SECTION 5

Perioperative pain management

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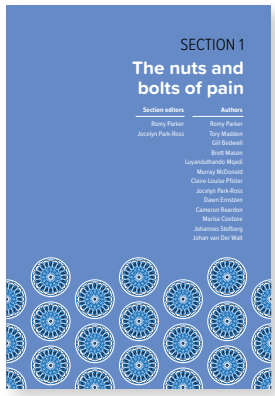
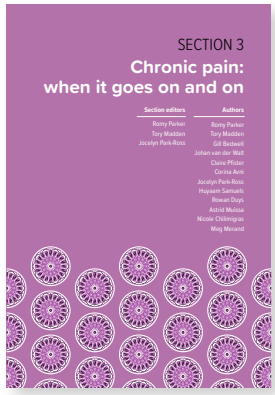
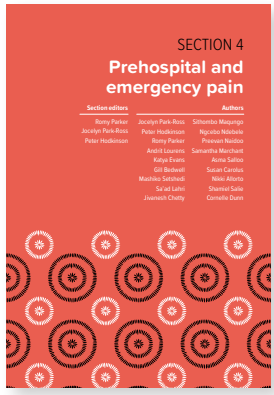
About the book

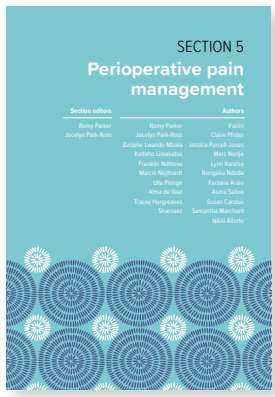
This open access textbook is aimed at all healthcare disciplines, including nurses, doctors, rehabilitation and allied healthcare and prehospital care providers.

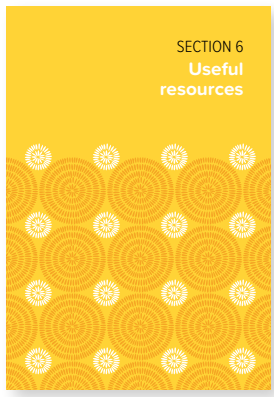
Throughout the book, essential evidence-based pain knowledge is interwoven with contextual case studies and patient stories, centering the patient experience to enhance understanding of the physiology, assessment, and treatment of pain.











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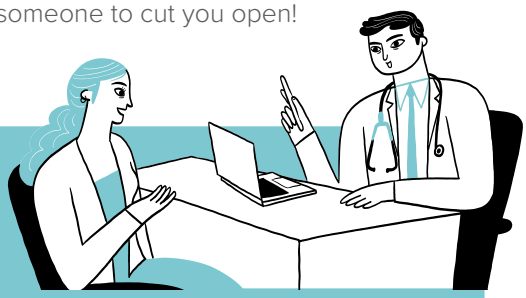
Contents

1 Introduction

Romy Parker
Marcin Nejthardt
Ulla Plenge
Alma de Vaal
Tracey Hargreaves

Surgery can be a lifesaving and life-altering event. It has the potential to change lives in multiple ways. But, surgery can also be a frightening or even terrifying event. People having surgery may be hopeful and optimistic that the operation is going to make a difference to their life. But they may also be frightened of what is going to happen and the possible outcome. They may be confused, unconscious, or delirious. It is likely that they will have more than one feeling, a mix of all of the above. As healthcare professionals we need to recognise that what we see and work with on a daily basis and consider normal, isn't normal for the person undergoing surgery. We, as healthcare professionals, may feel at home in a hospital, we might find the smells and sights and sounds non-threatening, or even enjoy them. But for many people, the hospital and clinical environment is threatening. The sights, the sounds and the smells may trigger a range of emotions. Positive emotions including hope that the surgery will go well and have a positive outcome. But also, negative emotions linked to feeling vulnerable, fearful of things going wrong, fear of not being in control, and anxiety about the outcome of the surgery. And all these emotions, positive and negative are chemical reactions in our brains, and all may increase or decrease our risk of suffering pain.

People having surgery might have pain before the surgery has even started, and often are having surgery because of pain. Now let's consider pain in the context of surgery. Remember, pain is a conscious construct created in response to a perception of threat. If I am about to have surgery, for any reason, might this be a threatening context? If we consider all of the thoughts and emotions that are likely to present when someone is about to have surgery, might these thoughts and feelings increase their perception of threat? We could argue that it is always threatening to agree to, or even to ask someone to cut you open!



DON'T MISS THIS

Why is it important to optimise pain management post-surgery?

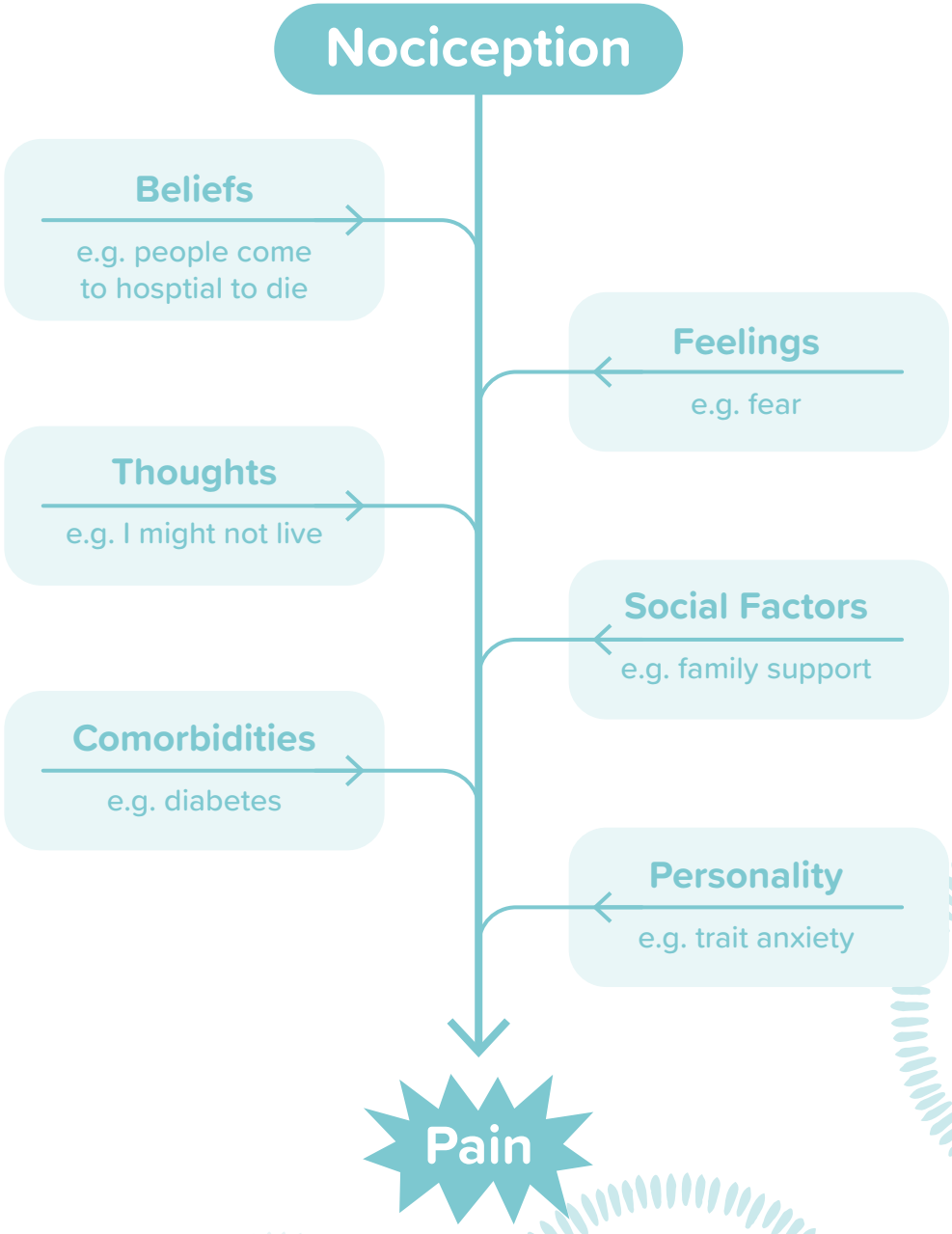
Apart from our duty as healthcare professionals to reduce suffering, it is important to optimise postoperative pain management because of the multiple negative consequences of pain on healing and recovery. Severe pain in the acute postoperative phase increases stress on the cardiac and pulmonary systems and there is an increased risk of death from myocardial infarction (1). Severe pain results in impaired wound healing and immune function, with risk of delayed healing and infection with increased length of hospital stay and increased exposure to the hospital environment. Poorly managed pain increases the risk of anastomotic failure (an anastomosis is where two tubes, fibres or channels have been surgically joined together), of delayed union of fractures and of wound breakdown. People with poorly managed pain also have a higher risk of postoperative nausea and vomiting.

There are also longer-term consequences to poorly managed acute pain after surgery. People take longer to mobilise, recover, and rehabilitate if they have poorly managed pain (2). Finally, severe pain in the acute postoperative phase increases the risk of developing chronic postsurgical pain (CPSP) which occurs in 10-30% of people who have had surgery (3).

It should be no surprise to you that 95% of people undergoing surgery report pain afterwards (4, 5). Not only does surgery result in tissue damage with inflammatory processes, contributing to nociception, and nerve injuries with consequent neuropathic mechanisms, but it also occurs in a context which may contribute to pain (6). Therefore, to effectively manage the pain from surgery, we need to think beyond the tissue damage to all of the factors that may be contributing to pain (Figure 5.1).

All of this means that managing pain around surgery must go beyond the surgery itself to being centred on the person. To effectively manage postoperative pain, we must consider this person, in this context.

Figure 5.1: Variables which may be contributing to pain post-surgery



DON'T MISS THIS

Managing postoperative pain means paying attention throughout the perioperative period

Perioperative pain management means we must manage pain preoperatively, intraoperatively, postoperatively and through discharge to the follow-up stage. We must consider nociceptive and neuropathic mechanisms at each stage of this process. We must also consider all the variables which might contribute to a perception of threat throughout.

Preoperative

- Education and setting expectations
- Shared decision-making about treatment plans
- Optimising management of current pain
- Preemptive multimodal anaesthesia
- Non-pharmacological strategies to reduce anxiety and pain

Intraoperative

- Collaborative communication with everyone in the team about treatment plans
- Procedure-specific and patient-specific neuraxial and/or regional anaesthesia
- Procedure-specific and patient-specific local anaesthesia
- Consider intraoperative lignocaine infusion if regional anesthesia is not possible
- Consider analgesic-dose ketamine

Postoperative

- Non-pharmacological analgesia and anxiolysis e.g. TENS, breathing, mindfulness, distraction
- Continue multimodal analgesia
- Reinforce educaiton and expectations
- Early mobilisation
- Multimodal analgesia by-the-clock
- Pain assessment by-the-clock with analgesia adjustment as needed
- If opioids have been used, implement weaning schedule as planned

Discharge

- Continue with multimodal analgesia by-the-clock
- Pain management exit plans discussed and agreed to, especially if being discharged with opioids
- Safe medication storage and disposal discussed

Follow up

- At 4 to 7 days or at most at 2 weeks - assess pain, weaning plan, sleep and mobilisation
- Review education and rehabilitation plan and expectations of recovery

Principles of preoperative management

Effective postoperative pain management starts with person-centred preoperative assessment and management. Step one is education of the person and their family or carers (3). It is helpful to ensure that the person who is undergoing surgery understands the why, the what and the how of their planned operation (Table 5.1). People who have received personalised education about their surgery appear to have a better acute postoperative experience with less anxiety and reduced use of healthcare services in the year following their surgery (7). If the surgery will be conducted during a planned admission, then this engagement can occur in the pre-admission phase. However, in many resource-poor settings, it is difficult for people to access care pre-admission and therefore these interventions will occur when they have been admitted to the hospital for their surgery.

Table 5.1: Ensure that the person undergoing surgery has an understanding of "the why, the what and the how"

Why?	• Why is the surgery being planned? • Has the person having surgery (and their family/carers) had the opportunity to weigh up the risks and benefits of having the surgery? • Do they feel that this is the correct decision for them?
What?	• What is the surgery being planned? • Does the person having surgery understand what will be done in the operation itself?
How?	• Does the person having surgery understand the process of what will happen? • Before admission – what can they do to prepare for the best outcome possible? (including what to pack and bring to hospital, learning and practicing mindfulness-based strategies, how to mobilise after their surgery e.g. with crutches and optimising their health prior to surgery including optimising their pain management) • Once admitted – What will happen on the day they present to hospital? How will things be managed on the ward? What will happen up to the time they are taken to theatre? • In theatre – What can they expect to experience? How can their family be kept informed of their progress What will happen in postoperative recovery? • Postoperative – how they may feel, including pain, how to score their pain and how important it is to tell the staff about their pain, how their pain will be managed, what tests or investigations may be done postoperatively, how long they can expect to be in hospital.

Perhaps the most important component of preoperative education is to ensure realistic expectations (1). If someone has chosen to have a total hip replacement because of their unrelenting pain, they need to be reassured that it is normal, and even to be expected to have some pain after their surgery. Pain after their surgery does not mean that something has gone wrong or that the surgery was a failure! They need to know what to expect and how long their postoperative pain is likely to last for.

This means that not only do we as healthcare professionals need to know about tissue healing times (remember this from Section 1?), we need to be able to teach people who are having surgery about tissue healing times too. When people who have had surgery know about normal healing processes, they are able to work with their healthcare team to optimise their recovery, particularly during the first six weeks as they move through the inflammatory phase (when pain may flare up) and the second phase of healing, the regeneration (or tissue proliferation) phase. Helping them to understand that in the first three days (inflammatory peak) after their operation, the team (including them) will use multiple methods to manage

their pain before gradually stepping down the analgesia over the next two weeks (through the inflammatory phase), can reduce anxiety about their postoperative recovery. It is also helpful to have clear expectations about pain and discomfort up to six weeks (end of the tissue regeneration phase), and how to manage any pain post discharge. Information materials or posters such as the one below can be helpful to educate and empower people undergoing surgery to work with their team to manage their pain (Figure 5.3).

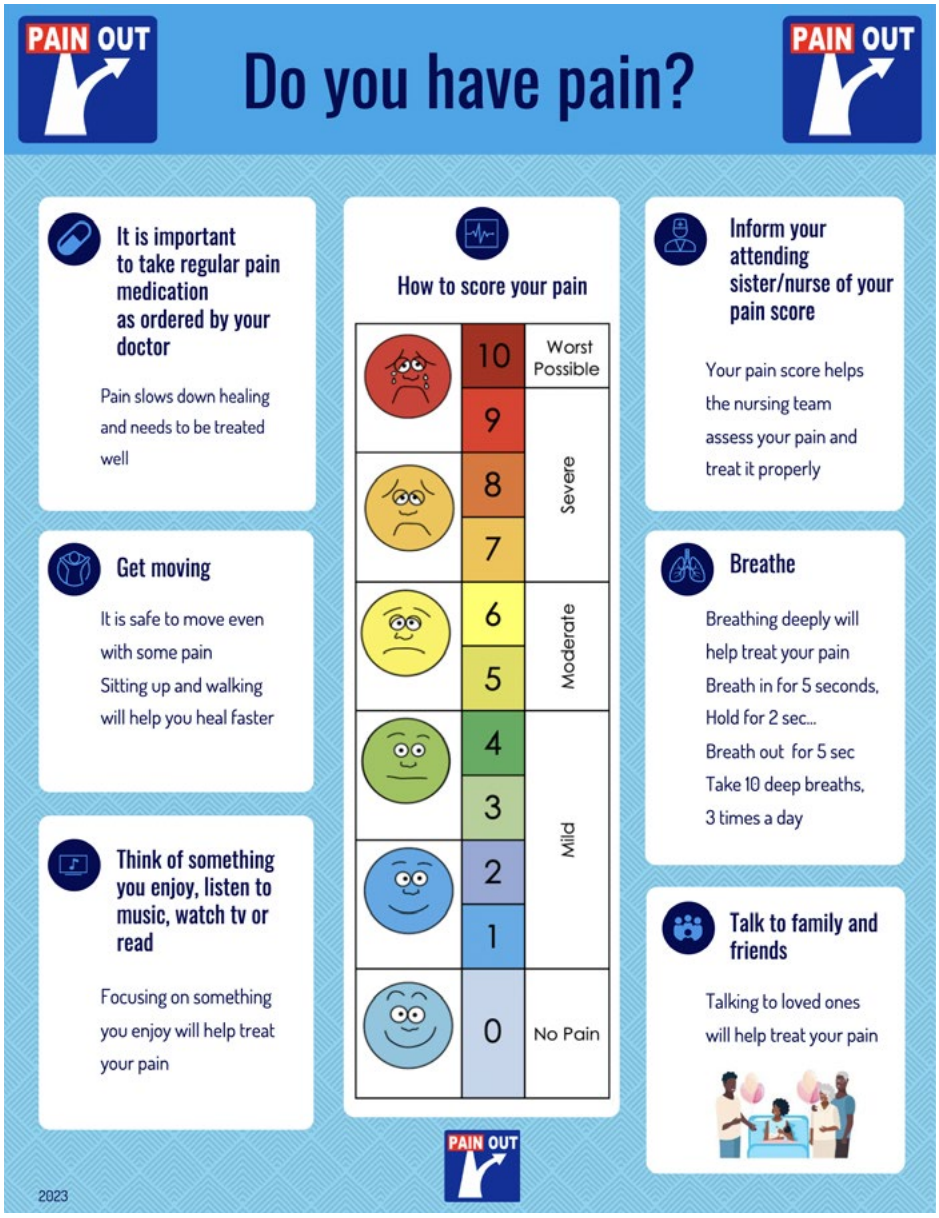


Figure 5.2: Poster to educate people undergoing surgery on how they can contribute to managing their pain (2)

Step two in the preoperative phase is to optimise management of any current pain. People with preoperative chronic pain are at high risk of poorer outcomes and developing CPSP (8). Prior to admission, ensure that their existing pain has been fully assessed, classified as acute, chronic, nociceptive, nociplastic, neuropathic or a combination of these and optimise their pain management. In people with chronic

nociplastic pain, it may be beneficial to delay surgery (if it is safe to do so) until the nociplastic component of their pain is reduced. This may be the case in conditions such as osteoarthritis of the hip or knee in which a joint replacement (arthroplasty) is planned. As discussed earlier in this book, people with osteoarthritis-related pain often present with a combination of nociceptive and nociplastic pain. In these cases, prehabilitation may be effective to reduce their pain and maximise the benefit of the joint replacement (9). Prehabilitation is a process which most often involves physiotherapy but can include occupational therapy, nurses, and doctors working with the person who is going to have surgery to optimise their function and health prior to surgery. In addition to optimising pain management prior to surgery, it is important for the anaesthetists to consider what analgesia the person is currently using as this needs to be accounted for when planning intraoperative and postoperative analgesia.

DEEP DIVE

The ideal preoperative assessment clinic

People coming to have an operation often fail to understand that surgery is not a quick fix. Many seemingly routine surgical procedures are followed by a prolonged recovery and can be accompanied by many unexpected physical and psychological consequences. Signing up for surgery is no different to deciding to enter a serious sporting event. It would be foolish to run the Comrades Marathon or ride the Cape Epic cycle race without training. Undergoing surgery is no different.

Anaesthetic or preoperative assessment clinics take advantage of the time before surgery to get people into the best possible medical shape for their surgery. Mental preparation and clarity on what lies ahead are addressed too. It is important for someone undergoing surgery to understand that their underlying health and fitness will predict how well they're likely to do. So it makes sense to get in as good a shape as possible!

Preoperative clinics are often staffed by nursing staff and anaesthetists. Referral to other disciplines is common, especially physiotherapy, occupational health and, of course, medical specialties such as cardiology, pulmonology and endocrinology. At the preoperative consultation, a full assessment is done to identify correctable factors such as hypertension, diabetes, ischaemic heart disease and heart failure to ensure that people are on appropriate treatment prior to their surgery. At this assessment, their pain can also be evaluated to allow the treating team to plan their perioperative management. This approach reduces the chances of having to cancel the surgery at the last minute, and it improves long term quality of life.

This preoperative consultation is also an ideal time to educate and empower the person who is going to have surgery about the why, the what and the how. A crucial component of the visit is to clarify for the patient what the procedure entails, discuss in detail what happens on the day of surgery, formulate an anaesthetic plan and talk about different pain management options. These pain management options consider the type of surgery as well as the risks to the person having surgery. This is an opportunity to empower people by inviting them to express an opinion on what pain management strategies may be most acceptable to them, and learn about how their pain will be assessed after the surgery. There is also the opportunity to learn about how they will move after the surgery e.g. how to walk with crutches and how to get out of bed.

Other crucial interventions include discussions on smoking cessation. Research supports that people are more likely to make life changing and habit-forming decisions around the time of surgery. Other important prehabilitation interventions support cardiopulmonary and strength training. Fitter, stronger people have fewer complications.

Finally, at the heart of every preoperative consultation is a discussion of risks and benefits. It is important for everyone in the team, especially the person having surgery, to understand what risks are acceptable to take in order to hopefully have a successful operation. An important aspect of the clinic is to provide user-friendly information to help guide the person having surgery in making an informed decision about the step of going ahead with the operation. Once the decision to proceed is made the clinics provide written plans for the person, their surgeon and other members of the team on how best to manage the timing and dosage of any medication that they may already be on.

Principles of intraoperative pain management

A person might be unconscious or have no sensation where the surgery is being performed, and therefore have no pain during surgery. However, this does not mean that pain can be ignored at this stage as nociception will certainly occur and must be actively targeted during surgery. While the primary methods to target nociception are pharmacological, the non-pharmacological approaches which can be used in theatre are imperative when regional techniques are used, and the patient is conscious.

Multimodal analgesic approaches are now accepted as the best method to optimise pain management. Multimodal analgesia means using more than one class of pharmacological agent or drug to target as many different receptors in the nociceptive pathway as possible, with the goal of achieving the best possible pain control with the least side effects. This means considering what pharmacological agents can be used to target activity in the peripheral nervous system, in the spinal cord and in the brain. Three components that are universally recommended are (1-3, 10):

1. **Intraoperative initiation of a full daily dose of 1 to 2 nonopioid analgesics including**
- Paracetamol
- NSAIDs or selective cox-2 inhibitor (when not contraindicated)

2. **Local or regional anaesthetic techniques**
- Neuraxial analgesia
- Regional/peripheral nerve blocks
- Interfascial plane blocks
- Surgical site infiltration

3. **Consider analgesic adjuncts**
- Dexamethasone
- Gabapentinoids
- Ketamine
- Alpha-2 receptor agonists
- Lignocaine infusion
- Magnesium
- Dexmedetomidine

→

Next page: Figure 5.3: Perioperative NSAID decision tool for adult patients undergoing orthopaedic surgery

Perioperative NSAID decision-tool for adult patients undergoing orthopaedic surgery

1	**Ibuprofen (≤ 7 days)** should be considered in ALL patients undergoing orthopaedic procedures
2	All ASA 1 (American Society of Anesthesiologists - Level 1, normal health patient) patients may receive **ibuprofen (400 mg TDS for ≤ 7 days)**
3	Board **ibuprofen** for **10h00, 16h00 & 22h00**
4	Consider using **parecoxib 40 mg 12 hourly intravenously** or **indomethacin 100 mg 12 hourly per rectum** when oral intake not possible

RENAL

Concern of preoperative, intraoperative or postoperative hypovolaemia causing renal hypoperfusion	YES → **NSAIDs not recommended**
eGFR < 60 ml/min	

Ibuprofen (≤ 7 days) can be administered with acceptable risk in patients with:

- eGFR ≥ 60 ml/min

CVS & CNS

Acute coronary syndrome +/- revascularisation < 3 months ago	YES → **NSAIDs not recommended**
Angina Class CCS III & IV	
Heart failure NYHA III & IV	
Intracranial hemorrhage < 1 month ago	
Intracranial hemorrhage < 3 months ago & concomitant antithrombotic treatment	

Ibuprofen (≤ 7 days) can be administered with acceptable risk in patients with*:

- Acute coronary syndrome +/- revascularisation ≥ 3 months ago
- Chronic stable angina Class CCS I & II
- Hypertension (well controlled and poorly controlled)
- Diabetes (well controlled and poorly controlled)
- Heart failure NYHA I & II
- Intracranial hemorrhage > 1 month ago (if not on antithrombotic treatment) and > 3 months ago, if on concomitant low-dose aspirin
- Ischaemic stroke on concomitant low-dose aspirin

*In patients on low-dose aspirin for secondary cardiovascular prevention, ibuprofen should be administered minimum 30 minutes after aspirin administration

GASTROINTESTINAL

GI-bleeding/perforation**	YES → **NSAIDs not recommended**
Peptic ulcer disease < 3 months ago	
Co-administration of single agent antiplatelet (P2Y12 antagonists - eg. clopidogrel), dual antiplatelet treatment or anticoagulants (DOACs/Vit K antagonists)	

Add **daily Proton Pump Inhibitor*** to **ibuprofen treatment (≤ 7 days)** in patients with:

- Gastro Oesophageal Reflux Disease (GORD)
- Peptic ulcer disease ≥ 3 months ago
- Eradicated Helicobacter Pylori
- Concomitant use of low dose aspirin, corticosteroids or SSRIs
- Severe rheumatoid arthritis
- Age ≥ 75 years
- Prolonged periods (>12 hours) NPO awaiting urgent or emergency surgery

**In the absence of alternative analgesia, a short course of selective NSAIDs (eg. celecoxib/parecoxib) + PPI can be administered if > 3 months since GI-bleed/perforation

***Administer daily omeprazole 20 mg or lansoprazole 30 mg during NSAID treatment

MISCELLANEOUS

Impaired synthetic liver function****	YES → **NSAIDs not recommended**
Multiple myeloma	
Bleeding disorders (eg. haemophilia, Von Willebrand disease, qualitative or quantitative platelet defects)	

Ibuprofen (≤ 7 days) can be administered with acceptable risk in patients with:

- Inflammatory bowel disease (non active)
- Neutropenia
- Porphyria (indomethacin, parecoxib & celecoxib are also safe to use)
- Age < 75 years

****In the absence of alternative analgesia, a short course of ibuprofen can be administered to patients with mild liver impairment (Child Pugh A) with fully compensated liver disease, i.e. no jaundice, ascites or abnormal synthetic liver function (INR > 1.4, Albumin<35 g/L. Platelets <150)

Aspirin/NSAID-exacerbated respiratory disease

RESPIRATORY

Poorly controlled asthma with hyper-reactivity to COX-1 inhibitors	YES → **NSAIDs are contraindicated**
A history of a severe reaction involving angioedema, urticaria or cardiovascular collapse to COX-1 inhibitors	
Isolated respiratory reactions***** to non-selective NSAIDs (COX-1 inhibitors, eg. aspirin/ibuprofen)	YES → **Selective NSAIDs (COX-2 inhibitors, eg. celecoxib/parecoxib) can safely be administered**
Patients with mild to moderate asthma, who experience worsening of their asthma on exposure to COX-1 inhibitors	

*****I.e. wheezing, rhinitis, nasal congestion, cough, shortness of breath or asthma exacerbation

Canadian Cardiovascular Society (CCS) grading of angina pectoris		New York Heart Association (NYHA) Functional Classification	
Class I	Angina only during strenuous or prolonged physical activity	**Class I**	No limitation of physical activity
Class II	Slight limitation; angina only during vigorous physical activity	**Class II**	Slight limitation of physical activity
Class III	Moderate limitation; symptoms with everyday living activities	**Class III**	Marked limitation of physical activity
Class IV	Severe limitation; angina at rest/inability to perform any activity without angina	**Class IV**	Any physical activity causes discomfort - symptoms of heart failure at rest

In addition, for someone who is awake, consider noise reduction or music, mindfulness-based strategies or other distraction methods which they have chosen. Interestingly, low volume classical music played in theatre has also been demonstrated to reduce stress of all the members of the team and optimise surgical performance (11).

Other non-pharmacological strategies that can be used in theatre include paying attention to communication and comfort. Ensuring the person is handed over by name, that everyone is introduced and using clear instructions when checking consent and identification reduces anxiety for the person about have surgery. Taking the time to position the person as comfortably as possible on the theatre table, using pillows and blankets and ensuring that fluids to be given are the right temperature is also helpful.

Principles of postoperative pain management

Postoperative pain management starts as soon as the person who has had surgery leaves theatre. The principles of treatment include by-the-clock assessment and documentation of pain using a valid outcome measure and by-the-clock administration of analgesia. Pain assessment should include evaluation of pain at rest, and pain on movement such as getting out of bed and during ablutions. Administration of paracetamol and NSAIDS should continue by-the-clock ensuring that a full daily dose is administered (2).

At this stage, it is critical that the person with pain is empowered to engage with their pain management strategies using all non-pharmacological options available to them. These may include using TENS (12), mindfulness-based strategies, breathing, ice, movement, distraction and social support (13).
Ensuring the person knows how to position themselves with pillows and use the bed appropriately can also reduce pain.

DON'T MISS THIS

Human interaction is medicine for pain

Social support is an interesting method to consider as part of the multimodal non-pharmacological management strategy in the acute postoperative phase, as it involves the "meaning response" (previously known as the placebo response). Work on placebo analgesia has demonstrated that postoperative morphine has a greater effect when administered by a caring healthcare professional as opposed to administering this powerful analgesic by automated computerised dispenser or via patient-controlled analgesia (PCA) (14). This effect has been reproduced in various populations after a variety of surgeries. The results are consistent. When someone is administered an analgesic by a caring person, there is a larger analgesic effect, equivalent to a dose of morphine. This is hypothesised to be due to stimulation of the endogenous opioid mechanism. The opposite is also true, that when someone is anxious and afraid, the endogenous opioid system is blocked and pain becomes worse (15).

In other words, you, the healthcare professional, are a dose of morphine.

And, by extension, caring supporting friends and/or family may also be a dose of morphine!

Principles of managing pain post-discharge

Going home from hospital can be an exciting and frightening time for people who have had surgery. In the era of ERAS (no, not Taylor Swift's Tour but Enhanced Recovery After Surgery), we aim to optimise all aspects of people's care to enable discharge home as soon as possible. This does not mean that care ends when they go home, because they will continue to experience pain as they heal, and they need to be informed and equipped to enable them to manage their pain and recover fully.

Discharge planning and education needs to include information on: (i) care for the wound, (ii) mobilisation and rehabilitation priorities, and (iii) effective pain management. In terms of pain management, it is helpful for them to learn about what medication they will be taking home. People need to be educated to take their medication regularly and how to use analgesia that has been prescribed for breakthrough pain. It is also useful to learn about tissue healing times and to understand that during the first two weeks there will be inflammation and that this inflammation may contribute to pain. This should then be linked to education on how to use their analgesia over the first two weeks, and on how to titrate their analgesia down until they are only using paracetamol and how to reduce that dosage up to six weeks. Understanding the tissue healing processes up to three months is empowering for people who are having surgery.

Now, let's see how these principles can be applied for specific people undergoing a range of surgical procedures.

2 Phantom limb pain

From tragedy to triumph - Lwando's amputation journey

Lwando Mbola
Katleho Limakatso
Franklin Ndhlovu
Romy Parker

Introduction

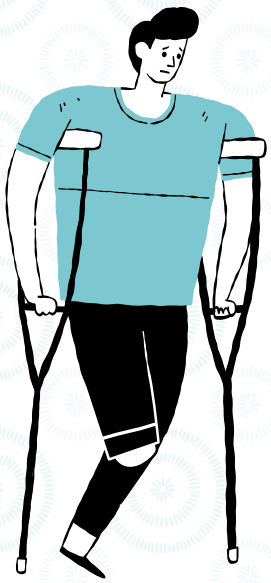
My name is Lwando. I am a 22-year-old male from Lusikisiki, a small town in the Eastern Cape Province of South Africa. I am a 5th year medical student at Walter Sisulu University in the Eastern Cape Province of South Africa. I have an above-knee amputation. It all started on the 28th of September 2022 when I was on my way to see my ophthalmologist. Little did I know that day would change my life forever.

I was in a taxi, sitting in the left front seat when suddenly, out of nowhere, a car collided with our taxi. The impact was brutal, and I found myself injured, but thankfully, I was conscious enough to see the extent of my injuries. My left thigh had a gruesome sight - my femur was protruding from it. I was in excruciating pain.

The Amputation Dilemma: A Gruelling Choice for Survival

Help arrived swiftly, and paramedics rushed me to hospital. As they transported me, they asked for my consent to sedate me because I was trapped in the wreckage. I agreed, and the next thing I knew, I woke up in another hospital in Port Shepstone, Kwa-Zulu Natal. The doctors informed me that my injuries were severe, with multiple fractures in my left leg - the femur, tibia, ankle joint, and toes. They had initially sought my mother's consent to conduct an amputation, but now that I was awake, they also asked for mine.

I knew this was a possibility from the crash site, but I hoped they could save my leg. Nevertheless, I trusted the doctors' judgment; they wouldn't consider amputating my leg if no other option remained. So, I gave my consent, and on the 29th of September 2022, I underwent the amputation surgery. I spent three weeks in the hospital recovering.



Epidemiology of traumatic amputations

The most common reason for people to undergo surgical amputation is as a result of complications from diabetes and atherosclerosis (16). This reflects the growing burden of non-communicable, chronic diseases of lifestyle globally (17). However, in young adults like Lwando, the most common reason for major lower limb amputation remains trauma.

Coping with amputation and embracing recovery

I was filled with fear and uncertainty the moment before my amputation surgery. I worried about how my life would change, especially regarding my studies and career aspirations. But I didn't regret my decision, more so after seeing a picture of my leg after the accident.

When I woke up from the surgery, I was initially in the Intensive Care Unit, but I requested to be transferred to the High Care Unit where I was familiar with the staff. That's when I realised the gravity of the situation – my leg was gone, with nothing but a swollen residual limb. Phantom limb pain (PLP) set in as the anaesthesia wore off, and this surreal sensation made it feel like my amputated leg was still there. I'd feel my foot twisting, itching on the sole, and having pins and needles-like sensations.

I was overwhelmed by thoughts about the future. Would I be able to continue my studies and become a neurosurgeon? How would my family at home react? I had no way to contact them, and it weighed heavily on my mind. However, the medical team helped me see the possibility of a fulfilling life post-amputation. It would have been more helpful to get this information before undergoing surgery. However, in the chaotic setting of the operating room, there isn't much time for in-depth discussions with patients.

Epidemiology of phantom limb pain post amputation

Over 80% of people who have had an amputation will suffer from phantom limb pain

Phantom limb pain is pain perceived as arising from the amputated limb. Just as Lwando has reflected, the pain is often described as burning, sharp, itching, and uncomfortable (18). Sometimes the pain can be felt because of the sensation that the limb is stuck in an abnormal anatomical position (19). Phantom limb pain is a common condition affecting up to 82% of people with amputations within one year post-amputation, and up to 87% of people with amputations in their lifetime (19). Phantom limb pain can be experienced by people with amputations due to trauma or complications of peripheral vascular disease. Persistent preoperative pain, that is pain at the site of the surgery, is commonly associated with PLP (20). Other risk factors consistently associated with PLP include residual limb pain, non-painful phantom sensations, depression, and not undergoing pre-amputation education/counselling (20).

Mechanisms of pain

Lwando's PLP can be classified as acute neuropathic-nociplastic pain. The pain is acute because its onset was day 1 post-amputation. The pain could be driven by neuropathic mechanisms, as evidenced by a severed nerve during the amputation. In addition, the words Lwando used to describe his pain are characteristic with neuropathic pain. Lastly, treatments targeting the peripheral nervous system (e.g., nerve block) provided pain relief suggesting that spontaneous ectopic firing of the peripheral nerve was contributing to his pain. The pain could also be driven by nociplastic mechanisms, as evidenced by the efficacy of mirror therapy for reducing his PLP.

Peripheral nervous system

Damage to the nerves triggers ectopic firing, resulting in abnormal sensations or pain in the phantom limb (21). It is known that triggering nociceptive activity at any nerve site, evokes symptoms in the distal regions innervated by that particular nerve. This is possibly the reason Lwando experienced PLP symptoms in the foot that was no longer there. Ongoing inflammation due to frank tissue damage at the site of his surgery, could have further sensitised the nerve, thereby leading to increased ectopic firing (22).

Spinal cord

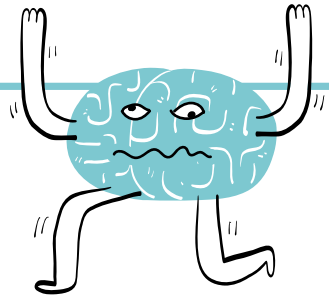
A barrage of nociception from ongoing ectopic firing of the peripheral nerves would have contributed to spinal cord sensitisation. In turn, this would have led to more nociception being transmitted to the brain and a decrease in descending inhibition (23). These changes are associated with residual limb sensitivity and pain with allodynia and secondary hyperalgesia in the areas adjacent to the site of surgery.

Brain

After amputation, the brain undergoes changes in its sensory and motor representations (24). These changes can cause maladaptive plasticity, where the brain perceives sensations or pain in the missing limb (25, 26). In addition, the ongoing pain experience can lead to central sensitisation, where the central nervous system becomes more sensitive to all nociceptive signals, thus amplifying the severity of PLP (27).

DEEP DIVE

Stochastic entanglement theory of PLP



The Stochastic Entanglement theory purports that PLP is triggered by the entanglement of sensory, motor, and pain networks (28). Ortiz-Catalan (28) argues that, "after amputation or sensorimotor impairment, the related motor and somatosensory circuitry (cortical and sub-cortical) falls into a susceptible state of perturbation and wiring to other networks or neurosignatures, such as that of pain perception. In a chaotic network state of somatosensory and motor deprivation, stochastic entanglement can occur between networks of sensorimotor processing and pain perception, which otherwise would be activated together exclusively due to noxious stimuli." Clinically, this theory could explain why movement intentions trigger or exacerbate PLP in individuals with amputations.

Synergistic systems

As we read Lwando's story we can see how his synergistic systems were probably contributing to his pain too. This was a highly stressful time which would have impacted on the functioning of his autonomic and endocrine systems. Lwando recalls that he was anxious and stressed about how his life would change, especially his studies and career aspirations and he was worried about how his family would react to his amputation. These stressors would have upregulated his HPA-axis with increased levels of cortisol further sensitising his nociceptive system. His mood was negatively affected by losing a limb, and he was fearful of the unknown future. Low mood has an impact on endocrine and immune function with increased expression of pro-inflammatory mediators which would also have increased his pain.

Knowledge is power

When asked about my management from the accident scene to Port Shepstone, I can't fault it. The medical team did an excellent job. They hadn't prepared me extensively for what lay ahead, but they did educate me about my injuries and the management plan, which involved the physiotherapist, psychiatrist, anaesthetist, psychologist, and an orthotist and prosthetist. Pharmacological management included Pethidine injection (IM), 6 hourly for breakthrough pain; Targinact® (PO), 12 hourly; and paracetamol (IV), PRN. As a medical student, I had an inherent fear of developing opioid addiction, so I tolerated mild pain throughout my hospitalisation, and only requested medication for breakthrough pain when its severity was above 5 on a 0–10 scale.

Psychological management included general counselling, and Acceptance and Commitment Therapy (ACT). The anaesthetist conducted a femoral nerve block on day 1 post-amputation. The orthotist and prosthetist focused on residual limb remodelling and prosthetic fitting. Physiotherapy involved mobilisation, muscle strengthening, balance retraining, and mirror therapy for pain management.

Mirror therapy became a crucial part of my recovery. Whenever I felt phantom pain, I'd use the mirror to trick my brain into thinking there was nothing there, and it helped alleviate the sensations. The medication helped mostly with my residual limb pain and healing.

Pain assessment

Lwando underwent a general assessment of his condition, with a focus on tissue healing, mobility, strength, balance, and overall well-being. Pain was assessed using a 0-10 verbal rating scale. No specific assessment was conducted for his PLP. Currently, there are no guidelines on the best approach for assessing PLP. However, several studies have identified key areas that are worth investigating in an individual with PLP. Using the O, P, Q, R, S, T, U, V, W principles, a thorough assessment can be conducted for PLP.

When assessing phantom limb pain it is also important to assess for non-painful phantom sensations which are often associated with pain and must be targeted in treatment.

Pain characteristics (O, P, Q, R, S, T)

Assess the onset of pain and what makes it better or worse (palliating and provoking factors), the quality or nature of the pain, explore how it radiates into the phantom limb, determine its severity on a 0-10 scale, and explore time in terms of frequency and duration of pain episodes. PLP is often variable and can be continuous or episodic. These factors are not just important to assess at baseline but should be reassessed over time to evaluate the efficacy of the treatment plan.

Other phantom sensations

In addition to pain, it is important to explore whether the person with pain experiences sensations such as itching, pressure or discomfort due to the sense that the phantom limb is stuck in an awkward or distressing position. There is evidence revealing a strong association between uncomfortable non-painful sensations and pain. In some cases, addressing non-painful sensations can influence PLP (20).

Pain patterns (R again)

Radiation should be explored further. Determine if the pain radiates to other areas of the body, such as into the residual limb. In a case where there is limb telescoping (i.e., the phantom limb feels as if it has retracted into the residual limb), PLP can be felt as arising from the residual limb (29). Therefore, assessing pain patterns helps to correctly identify targets for treatment.

Associated symptoms (W)

Inquire about any associated symptoms, such as muscle spasms, or residual limb discomfort, as these can cause mechanical irritation to the nerves in the residual limb and aggravate PLP.

Impact on daily life

Assess the impact of PLP on activities of daily living, sleep, and health-related quality of life.

Psychological factors (U, V, W)

Evaluate the emotional well-being and psychological state of the person with pain. It is clear from the pain mechanisms that anxiety, depression, and stress can influence PLP and coping mechanisms.

Pain knowledge (U, V)

Explore the person's understanding of their PLP and identify the gaps in their knowledge and understanding. This helps to tailor the Pain Science Education program to their needs.

Physical examination

Tinel's test and left/right judgments are important techniques to discern between peripheral nervous and central nervous system mechanisms.

A methodical approach to the physical examination of the person with PLP is useful to ensure that all possible mechanisms that may be contributing to pain are explored.

Tinel's test

A Tinel's test is performed by lightly tapping over the nerve. If the nerve is sensitised and contributing to pain, the tapping will trigger nociceptive activity at any point along the nerve and evoke symptoms in distal areas innervated by that nerve. A positive Tinel's test in this case would highlight the peripheral nervous system as an important treatment target.

Left/right judgments

People with amputations have a decreased ability to accurately identify the left limb from the right, and vice versa. In addition, they take longer to identify a limb representing their amputated limb than when identifying that which represents their intact limb (30, 31). Left/right judgements are used as a proxy for assessing maladaptive cortical reorganisation in the somatosensory cortices. Improving these outcomes is essential for effective pain management.

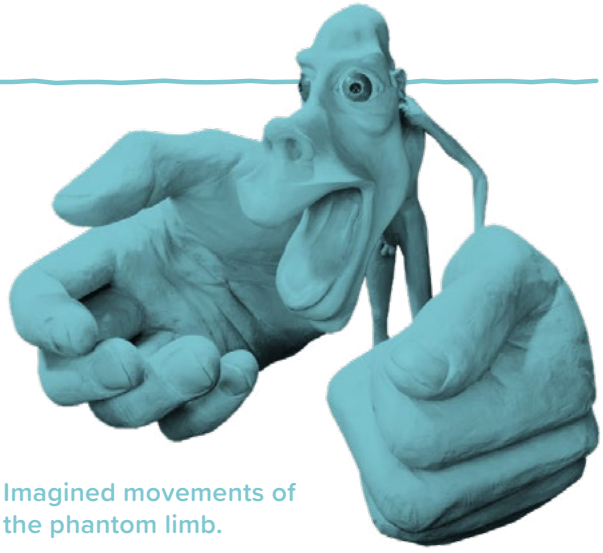
Two-point discrimination

This test is used to evaluate the integrity and sensitivity of an individual's somatosensory system, specifically the tactile discrimination abilities (32). It can reveal any impairments or changes in sensory perception. Improving presenting impairments is essential for effective pain management.

DON'T MISS THIS

Assessing PLP isn't complete until you have assessed the brain

Every assessment of a person with PLP must include an evaluation of whether the brain is contributing to their pain. In particular, assessment must include an evaluation of L/R discrimination, two-point discrimination or imagined movements. There is evidence showing that effective treatments reduce PLP by addressing neural mechanisms in the brain, emphasizing the dominant role of cortical neuroplasticity in PLP (34). Therefore, understanding and evaluating these brain-related factors should be a central focus in the assessment and treatment of PLP.



Imagined movements of the phantom limb.

This assessment is conducted to evaluate the individual's ability to imagine and move the phantom limb. Triggered or aggravated pain during the assessment would highlight central nervous system as an important treatment target. Pain or difficulty with imagining movements indicates that sensorimotor retraining treatments such as mirror therapy and graded motor imagery are indicated (33).

Resilience and Recovery: Navigating Life's New Path After Amputation

After the third week, the treating surgeon believed I would heal better at home. Despite my hesitation, I returned home and, after two weeks, resumed my studies in medicine. Life post-amputation had its challenges. Daily tasks required more effort, and standing during ward rounds sometimes caused discomfort. But with the support of my friends and family, I gradually adapted. Their encouragement and my positive mindset played a significant role in my recovery. Being optimistic and finding joy in small achievements, like taking a few steps, kept me going. I still experience episodic residual limb pain, likely due to the prosthesis quality; the socket is uncomfortable. Removing the prosthetic leg and massaging the residual limb improves my pain.

DEEP DIVE

Treatment recommendations for PLP

In a recent Expert Delphi study that generated treatment recommendations for PLP, mirror therapy, graded motor imagery, cognitive behavioural therapy, virtual reality training, sensory discrimination training, amitriptyline, and a use of a functional prosthesis, were considered effective for managing PLP (34). The representation of exercise-based, psychological, and pharmacological interventions highlights the importance of an interdisciplinary approach to effectively managing PLP. Graded motor imagery and mirror therapy were endorsed as the most effective treatments for PLP, highlighting the essential role of non-pharmacological approaches in managing PLP, particularly those aimed at addressing maladaptive changes in the central nervous system.

Phantom limb pain management

Lwando's pain management plan included a balanced use of pharmacological and non-pharmacological treatment targeting all of the mechanisms thought to contribute to PLP, including addressing psychological factors which upregulated the synergistic systems (34).

Treatments targeting peripheral mechanisms

Lignocaine is a local anaesthetic commonly used for its numbing properties. Lignocaine alleviates pain that has a peripheral nociceptive mechanism by blocking sodium channels that generate and conduct action potentials. When lignocaine blocks these channels, it prevents the transmission of ectopic nociceptive signals to the central nervous system (35). However, the positive effects of lignocaine are short-lasting (up to 2 hours). Therefore, bupivacaine is a preferred alternative because its duration of action is relatively longer (4–8 hours) (36).

Targeting peripheral mechanisms could have been optimised by using Transcutaneous Electrical Nerve Stimulation (TENS). This non-invasive technique uses a small, battery-operated device to deliver low-frequency electrical currents to the skin's surface through electrode pads. By sending electrical signals through the nerves, TENS may disrupt the ectopic nerve discharge associated with PLP. In addition, when used at a frequency of 100Hz, it can close the "pain gate", inhibiting the transmission of nociceptive signals to the brain. In addition, when used at a frequency of <10Hz, TENS can stimulate the release of endogenous opioids (endorphins), the body's natural painkillers. The endorphins help reduce the pain and create a sense of well-being (37).

Treatments targeting the central mechanisms of pain

Lwando's pharmacological management targeted general post-surgical pain, rather than specifically addressing PLP. The pharmacological treatments used were pethidine, Targinact®, and paracetamol, all of which are indicated for short-term use, up to day five post-amputation. To date, no pharmacological treatment has shown efficacy for managing PLP in the long-term (38), hence the current treatment recommendations emphasise the important role of non-pharmacological treatments in managing chronic PLP (34).

The components of Graded Motor Imagery are fundamental for the effective management of PLP.

Pethidine is a synthetic opioid analgesic that is primarily used to relieve moderate to severe pain. Pethidine alleviates pain by binding to mu-opioid receptors in the brain and spinal cord and by modulating the intensity of nociceptive signals from the site of amputation to the brain (39). Despite its efficacy, using pethidine is discouraged because of its high potential for addiction. Moreover, it has a higher risk of adverse side effects than other opioids (40). Morphine would have been a better alternative because it is more efficacious for managing pain and can be titrated more easily to achieve a desired clinical response.

Targinact® contains two active ingredients: oxycodone, an opioid analgesic and naloxone, an opioid receptor antagonist (41). Oxycodone is a strong opioid which alleviates pain by binding to mu-opioid receptors in the brain and spinal cord, to produce its analgesic effects. Naloxone is typically used to reverse the effects of opioid overdose. In this case, however, it is combined with the oxycodone to prevent opioid-induced constipation (42) and deter the misuse of the medication, as oxycodone alone is highly addictive (43). Given the addictive nature of

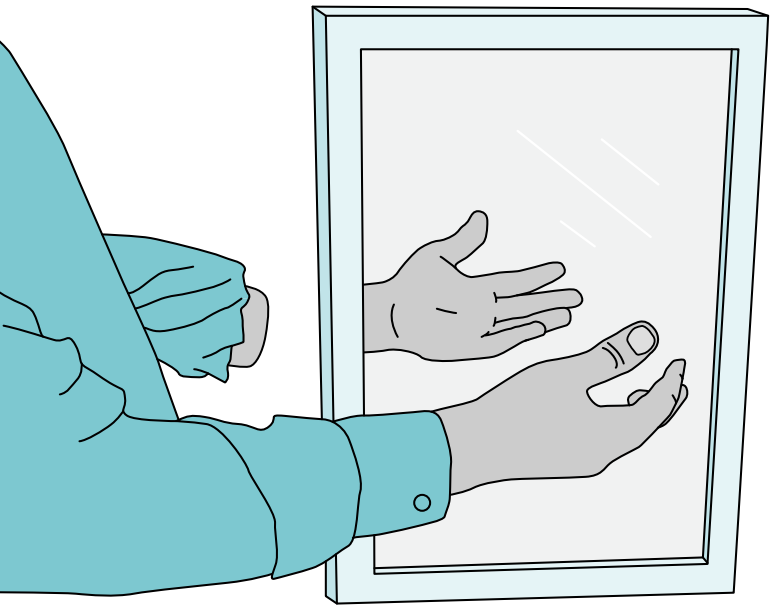


Figure 5.4: Using mirror feedback, the intact leg is reflected in the mirror to 'trick' the brain that the amputated leg is still there.

oxycodone, the protocol for perioperative acute pain management following lower limb amputation indicates its acute use for up to a maximum of 3–5 days post-amputation (44).

Lwando was also prescribed paracetamol by-the-clock, which has been described in detail in Chapter 1. He was discharged with a 7-day supply of oral opioids (e.g., tramadol). Prescribing NSAIDs and alpha-2-agonists would have helped, because combining these treatments with paracetamol helps mitigate opioid tolerance and dependence. There were no contraindications to the use of other non-opioid analgesics.

Mirror therapy is one step in the Graded Motor Imagery protocol, which was described in full in Section 3, Chapter 2. Mirror therapy or mirror visual feedback involves performing exercises with both the phantom and intact limbs while viewing the reflection of the intact limb in the mirror (31). Mirror therapy is proposed to reduce PLP by restoring sensory-motor integration that is disrupted after limb loss. In addition, it is thought to address maladaptive changes in the cortical areas representing the phantom limb. This reorganisation is associated with improvements in pain and motor function of the phantom limb (45). Seeing the mirror illusion can provide a sense of wholeness, often referred to as embodiment of the missing limb. This can have a profound psychological impact on people with amputations including an improvement in their body image.

Treatments targeting psychological factors associated with pain

Acceptance and commitment therapy (ACT) is a psychotherapeutic approach that aims to enhance the psychological well-being of people with amputations by fostering acceptance of the condition and encouraging them to engage in meaningful activities (46). The mechanism of action in reducing phantom limb pain through ACT lies in its ability to promote psychological flexibility. By teaching individuals to be more open to their feelings and experiences, including pain, and to commit to actions that enhance their quality of life, ACT can help people who have had an amputation to reduce the emotional distress and suffering associated with an adverse experience. Encouraging psychological flexibility and acceptance also targets the synergistic systems, decreasing sympathetic upregulation and reducing HPA-axis and immune reactivity.

Lwando has been on a long journey

> *In conclusion, my journey as an amputee has taught me that support, mental well-being, and maintaining a positive outlook are essential. While life may have taken an unexpected turn, I've learned to embrace it, and I'm looking forward to what the future holds.*

Lessons learnt

Lwando has come a long way since the life-altering amputation following a traumatic accident. After a challenging recovery period, including emotional turmoil, PLP, and physical adjustments, he has managed to resume his studies in medicine. At the time of writing, he is in the 5th year of his studies, and he looks forward to graduating next year. Despite the challenges he faces in his daily life, such as discomfort during ward rounds, Lwando remains resilient. His PLP and residual limb pain have subsided.

With unwavering support from his friends and family and a positive mindset, Lwando has found the strength to embrace his new reality. He understands the importance of mental well-being and maintaining a positive outlook, which has become essential in his journey. Although life took an unexpected turn, Lwando is looking forward to the future with determination and optimism. His story serves as an inspiring testament to the power of perseverance and adaptability in the face of adversity.

1. **Timely medical attention saves lives:** Lwando's story emphasizes the critical importance of receiving immediate medical attention following a traumatic event. A swift response from paramedics and immediate transfer to a hospital played a pivotal role in his survival and successful treatment. Timely medical intervention can significantly improve outcomes and minimise the long-term impact of severe injuries.

2. **The importance of person-centred care:** Lwando's experience highlights the critical role of informed consent in medical decisions, especially in cases as significant as amputation. This highlights the need for healthcare providers to prioritise patient education and engagement in the decision-making process, ensuring patients are well-prepared for life post-amputation.

3. **Multimodal pain management:** Lwando's pain management plan combined pharmacological and non-pharmacological approaches, emphasising the effectiveness of a comprehensive, multimodal approach to pain relief.

4. **A biopsychosocial approach to healthcare:** Lwando's experience highlights the importance of a biopsychosocial approach in healthcare, where health professionals consider not only the physical aspects but also the emotional and psychological well-being of the people in their care.

5. **Counselling for emotional healing:** Lwando's experience underscores the vital role of counselling in the context of amputation and recovery. Counselling provides a safe space for individuals to process their emotions, fears, and anxieties related to their life-altering circumstances. It helps people navigate the psychological challenges, cope with trauma, and develop strategies for resilience, ultimately contributing to their overall well-being and mental health during the recovery journey.

3 Caesarean section

"I want to look after my new baby, but it hurts too much!"

Sharnaaz
Claire Pfister
Jessica Purcell-Jones
Farzana Araie
Romy Parker
Jo Park-Ross

Introduction

My name is Sharnaaz, and I am a medical doctor. About a year ago I went in for an emergency c-section. This was my second Caesar.

I had an emergency c-section with my first child and even though it was quite an unplanned situation, I was quite prepared and I had a really great anaesthetist who listened very attentively to my concerns, and took my professional input into consideration. He assured me that he would do his best to make sure that I didn't have significant post-op (post operative) pain because that was a big concern of mine. I had never really had any major trauma, never had any major surgery before and I was a bit worried about how I would cope with having a new baby and dealing with post-op pain. I think for me, the most scary thing of the whole experience was being a recipient of medical care, rather than the provider! And the huge loss of power and change in the power dynamic that entails. The whole hospital experience was actually quite destabilising – from the loss of privacy and the constant interruptions, to now feeling more helpless than I have ever felt in my whole life. Also, with a new baby to take care of! And I think the helplessness of the baby is a profoundly scary thing to deal with as well. So, for my first Caesar, the anaesthetist gave me really excellent pain relief – I had bilateral TAP blocks (transversus abdominus plane block which is done by injecting local anaesthetic into the space between the transversus abdominus and external oblique muscles) *that were done as soon as the spinal was put in* ("spinal" is the type of anaesthetic one receives for this operation. It is a regional anaesthetic technique where local anaesthetic medication is injected into the cerebrospinal fluid through a needle into the back. It makes the body numb from the chest down to their feet. The mother is awake for the Caesar, but does not feel any pain.), *and then I also had a PCA for post-op pain afterwards* (patient-controlled analgesia: this is a special pump that contains very strong painkillers, usually opiates such as morphine. It is connected to the drip. The person with pain then has a button to administer the medication to themselves, as frequently as they would like. It has a lock-out time period designed into the pump mechanism so that they cannot overdose. It is very safe and ensures the person with pain is in control of their own pain management. It also means they are not reliant on nursing staff to administer strong painkillers). *I really felt that it couldn't have been managed better! It was obviously uncomfortable in the post-op period having to mobilise and pick up the baby and with the recovery, but I can't fault how it was done and I don't think any improvement could have been made.*

Sharnaaz received guideline-based pain management

Clinical practice guidelines, or guidelines, are a set of recommendations which are meant to guide clinical assessment and treatment. Guidelines are evidence-based, when evidence is available, or they may be expert consensus guidelines if there is insufficient evidence to guide treatment decision making. The PROSPECT working group (**P**rocedure **S**pecific postoperative pain managemen**T**) conducted a systematic review of the literature and published guidelines for the analgesic management of elective caesarean sections in 2020 which were updated in 2023 (Table x.1) (12, 47). The PROSPECT guidelines summarise the preoperative, intraoperative and postoperative steps which should be taken (unless contraindicated) to optimise pain management. As we review Sharnaaz's story, we can see that in her first CS, several of these treatments were delivered.

Table 5.2: The 2023 PROSPECT guidelines for the perioperative analgesic management of Caesarean section (47)

Treatment
Preoperatively
Intrathecal long-acting opioid (e.g. morphine 50-100µg or diamorphine up to 300µg). Epidural morphine 2-3mg or diamorphine up to 2-3mg may be used as an alternative, for example, when an epidural catheter is used as part of a combined spinal-epidural technique.
Oral paracetamol
Intraoperative after delivery
Intravenous paracetamol if not administered preoperatively.
Intravenous NSAIDs at the end of surgery.
Intravenous dexamethasone.
If intrathecal morphine is not used, local anaesthetic wound infiltration (single shot) and/or continuous infusion and/or fascial plan blocks such as transversus abdominus plane blocks , erector spinae plane blocks or quadratus lumborum blocks.
Postoperative
Oral or intravenous paracetamol.
Oral or intravenous NSAIDs.
Opioid for rescue or when other recommended strategies are not possible (e.g. contraindications to regional anaesthesia).
Analgesic adjuncts including transcutaneous electrical nerve stimulation (TENS).

Sharnaaz didn't have such a great experience the second time around

So, I went into the second Caesar fully expecting a similar situation the second time around. It was a different anaesthetist. I spoke to him at length about how my first caesarean section anaesthetic was done and again – he was quite friendly and seemed quite reassuring, and said that he had a way of doing his anaesthetics that had been tried and tested over a few decades and he was very experienced, and I should just leave things in his hands. Being an older, more-experienced colleague I should trust him – I had no choice but I thought that that was the right thing to do.

I think it was maybe just a combination of things – maybe a combination of that special kind of misfortune that you get when you are treating a colleague and things don't run smoothly, and you run into a little bit more trouble than you normally do... together with perhaps a bit of arrogance, and him not taking my views into account. But I had quite an inadequate anaesthetic in my opinion. The spinal took a while to be established and wore off quite quickly – I didn't get any TAP blocks! I had a drip that tissued in the post-op period immediately in recovery that was never replaced until many hours later so I couldn't get any rescue analgesia and there was a significant delay in giving me my scheduled analgesia because there were issues with the nursing staff at the hospital at that time (a drip that tissues means that the drip has stopped working and has swollen at the site of the drip. This means that intravenous medication cannot be given and will not work unless a new drip is inserted). *I also didn't get a PCA. So basically, it meant being in quite significant pain in the post-op period for about maybe four to six hours, until I was finally given something close to midnight that day, after having my Caesar at 8:30 in the morning and having some perfalgan* ***(intravenous paracetamol which is indicated for mild to moderate pain, regularly used in perioperative pain management)*** *at about 4pm. I couldn't get any scheduled drugs because there was only one nursing sister available and she only managed to get to me at about midnight.*

"I was in quite significant pain in the post-op period for about maybe four to six hours, until I was finally given something close to midnight that day, after having my Caesar at 8:30am!"

Epidemiology of Caesarean Sections

The caesarean section (CS) is one of the most common surgical procedures performed worldwide (48). The CS is regarded as major abdominal surgery and postoperative pain is common, with roughly half of all people reporting moderate to severe pain. Pain impedes recovery; it causes suffering, it overloads healthcare resources. In addition, much is expected of women post CS. While still recovering from their CS, they need to try to bond with, establish breastfeeding and start caring for and looking after their newborns (49). There is also a need for early mobilisation, as these women have a high risk of developing deep vein thromboses (blood clots). For all of these reasons, it is crucial to optimise activity by optimising pain management and avoid over sedation (50).

However, "approximately one in five women who undergo CS will experience severe acute postoperative pain" (51). This is a concern as, in the post-partum woman, the intensity and persistence of pain are risk factors for postpartum depression, can impact bonding with the baby and the successful establishment of

breastfeeding after delivery (52). Long term, women with unmanaged post CS pain are at risk of persistent postsurgical wound pain for months after their surgery, as well as persistent opioid use following a caesarean delivery (53, 54).

Despite the existence of clinical guidelines to optimise pain management, South African research conducted in a Cape Town hospital described that assessment of pain post-CS was poor, and this was coupled with poor management of pain with only 36% receiving the medications they were prescribed (52). In fact, a CS was the procedure with the highest incidence of inadequate analgesia postoperatively in a tertiary hospital in the Western Cape of South Africa (55). Recent work at another government hospital in the Western Cape suggests that pain management post CS continues to be a challenge with pain management severely lacking compared with international guidelines (12, 49). As we have heard from Sharnaaz, good evidence-based pain management can make a significant difference to the experience of giving birth through caesarean section.

Sharnaaz tries to make sense of what happened

> *It was a combination of things that led to this situation. It was some hospital logistics, I think some things were unavoidable. It seemed outrageous that in a facility that supposedly has everything at your disposal that even the most basic things weren't being attended to. I think, combined with the frustration and knowing how things should have been, and that feeling of being helpless and not being taken seriously, I think that compounded the pain a lot more. So, on top of the physical discomfort of being immediately post-op and having a little baby to take care of, I think all of those factors – the frustration made things feel just exponentially out of control. By midnight of that night, I think I was just climbing the curtains – quite distraught because I was in real agony, and I didn't know when it would end. I just wanted someone to tell me that someone was going to come over and they were going to make it go away, and I wasn't getting that reassurance until much, much later.*
>
> *Then over the next few days, it seemed as if – compared to my first experience – either my pain threshold was a lot lower or because my initial pain experience wasn't taken care of, I just seemed to not be able to get a handle on having adequate analgesia. Again, by the afternoon of the second day, I was feeling quite distressed and had somehow managed to convince myself that it wasn't pain that I was feeling but maybe there was something more sinister happening – that perhaps there was a surgical complication or a suture that was stuck in a muscle sheath – like something had gone wrong in my surgery, because this didn't seem to be something that should be expected.*

Mechanisms of pain

Sharnaaz's pain post CS is an example of acute nociceptive pain caused by a surgical procedure. The primary mechanism contributing to her pain was activity in the peripheral nociceptors, however, if we analyse the situation, we can also gain insight into how her brain and the synergistic systems contributed to her pain.

Peripheral nervous system

With the surgery there is clear tissue damage which will activate the nociceptors. As you should recall from Section 1, the opening of ion channels in the nociceptors enables an influx of Na+ and Ca2+ ions, which depolarise the membrane, setting off an action potential.

Tissue damage causes an inflammatory response and substances (such as histamine and prostaglandins, often referred to as the inflammatory soup) are released into the surrounding areas. The inflammatory soup sensitises the nociceptors, reducing their threshold for firing, increasing their basal rate of firing, and enables the generation of a supranormal strength of discharge. This process is known as peripheral sensitisation and clinically manifests as primary hyperalgesia.

Mothers who have had a CS are in a unique situation postoperatively. They cannot convalesce quietly, they have to care for their newborn and the mobility this requires can contribute significantly to their pain as the sensitised nociceptors will now fire in response to normal mechanical stimulus.

Spinal Cord

Without any local or regional anaesthesia (wound infiltration or TAP block), Sharnaaz's sensitised peripheral nociceptors would have bombarded her spinal cord with nociceptive input. This is likely to have caused central sensitisation manifesting as allodynia, secondary hyperalgesia and pain in the areas surrounding the wound. In addition, this sensitisation may have contributed to Sharnaaz's continued struggle to manage her pain over the next few days. Once the system is sensitised, it takes time for homeostasis to be restored.

Brain

Our brain tries to make sense of the signals it receives using context. Sharnaaz had previously had a pleasant postoperative experience and so she interpreted the pain she was in this time as a threat. She wondered whether there was a surgical problem, or whether a suture was tethering her rectus sheath. It is likely that these worries and concerns, as well as the feeling that she was not getting adequate care would have contributed to a reduction in descending inhibition and an increase in descending facilitation back to the spinal cord which would have further increased the amount of nociception coming up the spinal cord.

Synergistic systems

After birth some of the pregnancy hormones, such as oxytocin, may have a beneficial effect to reduce pain as they activate the descending inhibitory system. However, this pain relief is not adequate for the surgical pain of a CS, as exemplified by Sharnaaz's experience. In addition, the stress of the situation which Sharnaaz has so clearly described may have activated the endocrine system to increase nociception.

Sharnaaz had feelings of frustration, helplessness and being out of control in addition to pain. All of these feelings (including pain itself) would have activated the synergistic systems, adding to her pain.

Sharnaaz's psychological well-being was severely compromised by her pain. She had feelings of frustration, helplessness and being out of control in addition to pain. All of these feelings (including pain itself) would have activated the autonomic nervous system with the sympathetic "fight-or-flight" dominating activity. Pain post birth upregulating sympathetic activity can hinder breastmilk production and negatively impact a mother's ability to care for her baby.

A further synergistic consideration is sleep, or the lack of it for mothers of newborns. As we know, a lack of sleep increases pain and the risk of developing chronic nociplastic pain. Mothers of newborns wake often to feed and care for the child. Mothers of newborns post CS with poorly managed pain will also struggle to sleep due to pain, meaning that when they do have time to sleep, they may be unable to. This will further contribute to a spiral of pain.

Sharnaaz gets some care.

> *Eventually I got my surgeon to come over, and feel my abdomen, and check the wound, and reassured me that from a surgical perspective everything was fine – she just thought my pain was being inadequately controlled.*

Pain assessment

Sharnaaz's pain was not assessed adequately postoperatively for her second CS until her surgeon was called in. Pain should be assessed regularly by health care workers as a 5th vital sign (56). Vital signs (such as blood pressure and heart rate) are usually assessed every 4–6 hours, and postoperative pain assessment should follow the same pattern.

DON'T MISS THIS

Routine assessment of postoperative pain

Pain assessment in the postoperative period should be conducted and documented regularly. A methodical approach includes:

1. Ask if they have pain. If they have pain, where is it, and can they describe it?
2. Score the severity of their pain at rest using a pain scale. Use the same pain scale each time pain is reassessed.
3. Score the severity of their pain on movement including getting in and out of bed.
4. Ask whether the pain is preventing them from doing necessary activities e.g. can the new mother breastfeed and bond with her baby.
5. Ask whether they would like treatment for their pain.

Another important part of pain assessment is REASSESSMENT. Once appropriate analgesia has been administered it is essential to reassess if it has taken effect. The reassessment should be conducted about 20 minutes after administration of analgesia. As we can see, Sharnaaz was left without a working drip, we don't know if anyone assessed or reassessed her pain, and it was several hours before she received appropriate medication.

Another important part of pain assessment is to involve the person with pain in the decision-making process. This would begin by ensuring that we have established her Ideas, Concerns and Expectations (ICEs). Asking the person what has worked before and what she would like in terms of pain management, empowers them, and helps the team manage her pain better. The anaesthetist dismissed Sharnaaz's previous pain management and her concerns as they felt they "knew better". This was especially important for Sharnaaz who felt disempowered by this engagement, increasing her vulnerability to pain.

To fully assess Sharnaaz's pain, following the O, P, Q, R, S, T, U, V, W of pain is useful. While the mechanisms of pain might seem straightforward in someone with acute nociceptive pain, it is important to be methodical in the assessment approach to ensure that nothing is missed. As we review her story, we can gain insight into the **O**rigin of her pain (*significant pain in the post-op period)*, the **Q**uality (*I think I was just climbing the curtains – quite distraught because I was in real agony)*, the **S**everity (*agony*), and **T**reatment (*good description of what worked previously and her current response to perfalgan).* We also gain real insight into her **U**nderstanding of her pain at the time (*perhaps there was a surgical complication or a suture that was stuck in a muscle sheath – like something had gone wrong in my surgery, because this didn't seem to be something that should be expected)*, how it affected her **V**alues (*The whole hospital experience was actually quite destabilising – from the loss of privacy and the constant interruptions, to now feeling more helpless than I have ever felt in my whole life. Also, with a new baby to take care of!)* and **W**hat else (*And I think the helplessness of the baby is a profoundly scary thing to deal*

with as well) was impacting her at the time. All this information helps us to clinically reason that while the primary mechanism of Sharnaaz's postoperative pain was nociceptive, her brain was actively contributing to the pain experience.

The next step in assessing Sharnaaz's pain was a full physical examination, which her surgeon did. This is an important step to ensure that no red flags, no complications or infections are missed. On concluding this examination, the surgeon and Sharnaaz were reassured that her pain was from the surgery, her pain was likely increasing because it wasn't being well managed and she was in a spiral of sensitisation. Therefore, treatment needed to target the peripheral nervous system where nociception was originating, the spinal cord where there was sensitisation, the brain where her pain was being upregulated and her synergistic systems with fear and lack of sleep contributing to further sensitisation.

Sharnaaz feels better

> *Basically, she (the surgeon) got the nurse that was allocated to me as a patient and called her in and we had a little meeting, and the arrangement was that we increased the analgesia, that there should be absolutely no delays in giving the next dose. The nurse took it quite seriously and from about the second day onwards, things got a lot better. I did feel a bit embarrassed for not being able to tough it out and be a bit stoic about it but I think everyone has a plan until they get punched in the face! I think you might have ideas about how you will cope when you are in pain, but until it happens to you, you don't really know your personal resources and what your response will be like. Overwhelmingly the first 48 hours of that hospital stay, rather than being a joyous occasion welcoming my son into the world, it just seemed like it was two days of trying to not fall apart. And trying to maintain my composure in the face of quite a lot of discomfort. It did make things seem quite overwhelming. Definitely once my pain was better managed the entire situation – the whole situation changed for the better and became a much more positive experience.*

Pain management

In her first CS, Sharnaaz's pain was managed well with multimodal analgesia and several of the recommendations from the PROSPECT guidelines were implemented (47). We can now revisit the PROSPECT guidelines and consider what was different for Sharnaaz in her second CS.

Regular mulitmodal analegsia delivered by-the-clock made a significant difference to Sharnaaz.

It is unclear whether Sharnaaz received long-acting opioids in her spinal for the second CS. However, her description of it rapidly wearing off and being in extreme pain suggests that a short-acting opioid was utilised. Despite this, she was not given any local anaesthetic infiltration or regional analgesia, which the guidelines recommend if a long-acting opioid is not used in the spinal. The TAP block she received in her previous CS worked very effectively, which is evidence that a regional anaesthetic approach would likely have benefitted her for her second CS.

Postoperatively, the availability of analgesia was sorely lacking, and this cannot be solely attributed to the lack of a functioning drip or the lack of qualified nursing staff, as the backbone of analgesia post CS is paracetamol and NSAIDs which can be given orally and are not scheduled drugs. In fact, a pack could be left with the person to administer themselves. Patient-controlled analgesia (PCA) would have been a fabulous option for Sharnaaz as it would have allowed her to have autonomy over her pain management and would not have put pressure on the understaffed ward sisters. Sharnaaz's previous experience with a PCA shows the benefits it can have for mothers post CS. As we can see, once Sharnaaz was receiving regular analgesia by-the-clock her pain improved markedly.

DON'T MISS THIS

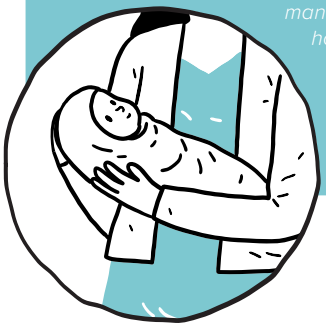
Three principles to optimise postoperative pain management

1. Routine assessment and documentation of pain
2. Analgesia administered by-the-clock
3. Ensuring that the full daily dose of multimodal non-opioid analgesics are prescribed and administered

DON'T MISS THIS

Sharnaaz's unmanaged pain had consequences.

"I was quite comfortable having breastfed my first child having done it for over a year, so I knew what I was doing. Obviously getting a new baby to latch is a bit of a learning curve initially, but breastfeeding is physiologically impossible to do if you are in discomfort. You need to relax to get a proper let-down reflex and to make the baby feel comfortable to latch properly! If you are in significant pain, physically sitting with the baby and trying to do that is difficult, and you don't get a proper let-down either. Obviously then there's also a newborn baby who is not settling because they aren't feeding properly and then that spirals out of control and your ability to deal with that situation also seems ... compromised. It has a lot more effects that just feeling pain – it affects how you emotionally process that whole experience, on bonding with the baby, on feeling competent to be the baby's caregiver... and I was hoping to be discharged a little earlier because I also had a toddler at home that was missing me because I had never been away from home. And that didn't happen because I had to stay an extra day because my surgeon wanted my pain to be managed properly before I went home. It delayed things and affected the whole family in that way."



A further non-pharmacological pain management option for Sharnaaz was TENS (transcutaneous electrical nerve stimulation) (47). TENS is a small, relatively inexpensive device, which can be used to deliver low frequency electrical current. TENS can be used as an opioid sparing treatment as it stimulates an endogenous opioid response when current is delivered at <10Hz. TENS can also be used at 100Hz, a dosage which stimulates Aβ fibres, "closing the gate" at the spinal cord. Physiotherapists are trained in the administration of TENS and often use it to manage pain when people are mobilising postoperatively. TENS is also safe for a person with pain to use on their own once they have been taught how to apply it.

Lessons learnt

The person undergoing surgery has a lot to contribute to their own management and to optimise their postoperative experience. Sharnaaz was well-educated, but not everyone is. Educate the person who is going to have surgery preoperatively on pain assessment and management, using pain rating scales. Also: LISTEN to the person with pain when planning analgesia. Encouraging them to be part of the pain management process empowers them and goes a long way to improving pain management.

Pre-empt the pain that a mother will experience once the spinal anaesthetic wears off by giving appropriate multimodal analgesia intraoperatively (e.g. paracetamol, NSAIDs, steroids, local anaesthetic and morphine- IM, IV or intrathecal).

Consider the constraints of the ward: Will there be adequate nursing staff to provide analgesia? Would a PCA be more appropriate? Can the person be given paracetamol and ibuprofen to administer to themselves?

If a drip tissues in theatre don't ignore it, replace it.

Uncontrolled pain in mothers not only impacts the mother but also her ability to bond with, breastfeed and care for her baby.

4 Total knee replacement

Fazlin
Ulla Plenge
Marc Nortje
Lynn Karelse
Bongeka Ndoda
Tracey Hargreaves
Romy Parker

Fazlin's new knee gives her new hope.

Introduction

My name is Fazlin and I am 63 years old. I live in my own house. I have twin girls who are 38 years old. My one daughter lives with me and one is married. The one that lives with me is working and she's mostly at work! My children give me everything that I need, I don't need to tell them, they do everything for me. My mother had 10 children, I have 3 brothers and 6 sisters. I am the oldest girl. I used to help my mother when I was a child. My mother and father went to work, and I raised half my siblings. From that time, I've liked to help people.

Many of the youngsters today don't know about polio. When I was a child, when I was 2 years, I had polio. And that time there wasn't doctors like today that help you. So, I grew up with this polio. My one leg is shorter than the other, when I walk, I limp, all those years. I was a seamstress, in the clothing factory for years. And this one leg keeps me all those years. I started working in the factory when I was 15, when I was 18, I became a seamstress on the machine, and I worked as a seamstress until I was 55 years old. Making clothes. Today I can make my own clothes and teach people how to make clothes.

After I was done with the factory, I teach people, youngsters, girls that don't work, I had a training school and SANZAF organised that for me. SANZAF is a Muslim organisation that helps people. So, I had the opportunity to have a training school. I put a lot of young girls that are on drugs, and young people that don't have work, I trained them. When they finished, they could go into a factory, change their lives. In that time, I trained 300 people, in 3½ years. Then I was 60 and now I had problem – I can't anymore!

I can't anymore – my other leg, the good one! For years I had arthritis but now - no man, here is something! I think I was 50 when I came to GSH the first time and they treat me as arthritis in my good leg. I remember the one doctor tell me: "no we can't do nothing for your leg now. But, if you can't walk anymore, then!" That was when I was 50 years old. There was pain, arthritis in my knee and my leg. Then when I was 60 there was a difference. I remembered what they told me - when you can't walk anymore then we do the operation. So, I thought, no there is something definitely wrong with me, I can't walk anymore, I can't manage, I can't climb up a pavement! It wasn't a pain, it was a nerve! Every step I took was like a nerve going through me. Like an electrical shock with every step, not a pain, not the arthritis pain. I couldn't take it anymore and I went to the day hospital.

Epidemiology

Fazlin was born in 1960 which means she was living in South Africa when vaccination programmes were not universal and therefore polio was not well-controlled. Between 1960 and 1965, there were several polio outbreaks with over 2000 cases reported (57). Throughout the 1960's and 1970's there were several more polio outbreaks prior to a gradual decline and control of the disease through dedicated vaccination programmes implemented in the 1980's.

Poliomyelitis is caused by a virus which results in an acute infection. In about 1% of people infected, the virus can spread to the CNS where it damages motor neurons in the spinal cord, the brainstem and in the motor cortex which results in neurological impairment (58). The common signs and symptoms of polio infection of the CNS include asymmetrical weakness of muscles, e.g. with Fazlin this was of her one leg. It can also affect swallowing, and bowel and bladder function. The most critical impact of polio is seen when the brainstem is affected. When this happens, the neurons which are necessary for the regulation of respiration can be destroyed meaning that people are unable to breathe unsupported and require ventilatory care. Recovery from polio infection is variable with younger people having a better recovery profile thanks to the increased plasticity of the nervous system (58). Fazlin was young when she developed polio, and while she recovered and was able to walk again, like many people who have had the disease, her affected leg was always weaker than the other and did not grow to the same length. This means that throughout her life, her leg unaffected by polio bore the brunt of the load.

Poliomyelitis in childhood has lifetime consequences. Outbreaks of poliomyelitis have been significantly reduced through dedicated vaccination programs.

As we discussed in Section 2 (Chapter 3 with Howard), osteoarthritis is a common condition affecting over 80% of people over the age of 60 (59). However, not everyone with OA has symptoms. The incidence of symptomatic OA ranges from 88 (hip) to 240 (knee) per 100 000 people (60). You now know that there are several risk factors for developing symptomatic OA, and we can see that Fazlin has several of these including her age, being a woman and suffering from trauma. The other risk factors include genetics, being obese and having muscle weakness.

As we heard before from Howard, Fazlin tells us that her OA pain affected her in many ways.

Fazlin feels like an old, old woman!

> *I went to the doctor, and I explained I am 63 now but I feel like an old old woman! I never feel like this before but in a year's time I see this problem I have will be worse and now what is worse with my polio leg it can't help me. So, I told her I have to fix my one leg to help me further. If I can't fix this leg, I won't be able to get along. I'm not a person that can sit, I need to help people, that is my passion! My passion is to serve people, I need to serve my community. I can't sit the whole time. The problem was not the pain, I must be busy I like to cook that is my passion and I need to stand to do that. I also have my mother still, she is 87. I used to go to her every second day, and I go help her. I lost my father a year ago, now my mother is a little bit lonely, and she also has arthritis in her legs. Arthritis, it's a family thing I think so. But what makes it worse for me is the polio.*
>
> *I didn't have pain pain, it's just like the nerve. I would need to rest, I need to sit the whole day. I had my off days, very very bad off days that I can't walk, I cant' go to the shop to buy a litre of milk. I have to find someone to go buy for me. That was the thing mostly. And my mother, I used to go to her and travel with public transport and I can't even go to my mother anymore. They have to bring my mother to me. So, it was vice versa – my mother come to me because my leg was in a bad condition.*

Table 5.3: Assessment findings suggesting that Fazlin's pain was primarily nociceptive vs the findings of someone with nociceptive and nociplastic OA-related pain.

Mechanisms of Fazlin's pain

Fazlin has had pain in her knee for many years, this means she has chronic pain related to her OA as it has been present on most days for more than 3 months (61). However, we need to explore whether her pain is nociceptive, neuropathic, nociplastic, or a combination of these. If we explore the characteristics of her pain prior to surgery, it appears to be predominantly nociceptive in nature. We have summarised the preoperative assessment findings which point us in this direction in Table 5.3.

Gather information on the...	Fazlin's nociceptive OA-related knee pain	Nociceptive and nociplastic OA-related knee pain
Onset	Fazlin is able to identify a clear timeline of when her pain started and how it has steadily progressed over the years. She also presents with evidence of ongoing tissue healing processes.	Someone with a combination of nociceptive and nociplastic mechanisms often presents with pain suddenly, or with a sudden worsening of their pain despite radiographic evidence that it has been progressing for years. There is also often no evidence of any mechanical or structural change associated with the increase in pain.
Provoking and palliating activities	Fazlin is clear that her knee feels worse when she stands or walks on that leg. It feels better with rest.	When nociplastic mechanisms are contributing to the OA-related pain, people often find that rest or not using the leg does not help. Their pain is present all the time or they simply struggle to identify any provoking or palliating factors.
Quality of the pain	Fazlin has had what she calls "pain pain" for years. But now, she describes a nerve shooting pain when she stands on that leg. This could suggest a neuropathic mechanism but as she has no other signs of neuropathic pain it may be an indication of mechanical changes in the knee causing acute nociception.	When someone's OA-related pain has a nociplastic component the quality tends to be less specific, a more vague, deep pain, "it hurts", "it's sore".
Region or radiation	Fazlin has described her pain localised to a discreet area with a clear localised referral to the knee	When there is a nociplastic component, the pain is often widespread, in multiple anatomical areas which don't link to peripheral or spinal cord neuroanatomy. People with nociplastic components to their pain also often have pain at other sites.
Severity	Can be mild, moderate, or severe. Severity does not assist clinical reasoning for pain mechanisms.	Can be mild, moderate, or severe. Severity does not assist clinical reasoning for pain mechanisms.
Treatment	Fazlin has noted that her pain responds well to anti-inflammatory treatments, analgesics, and rest. She may also have noticed that ice helps too.	Poor response to treatments. If ice has been tried, it will make the pain worse.

A full physical examination would be needed to confirm that Fazlin's pain is primarily nociceptive. In summary we would be looking for:

- The ability to reproduce her pain on physical examination.
- Signs of inflammation in the affected joint.
- No allodynia, or if allodynia is present it is restricted to the area of inflammation around the joint.
- A normal response to physical activity (remember Sensitivity to Physical Activity? Reduced pain after exercise or a raised pressure pain threshold after exercise).
- A score of <40 on the Central Sensitisation Inventory.
- Normal two-point discrimination.
- Normal left-right discrimination.
- No aggravation of pain on imagining movement.

Fazlin's assessment would also include an evaluation of her health generally to evaluate whether her synergistic systems are upregulated and contributing to a sensitised nervous system and nociplastic pain. Fazlin is well, she has no indication of endocrine, immune or autonomic dysfunction. She is also sleeping well, engaging fully with her family and while she is worried about her knee, she reports her mental health as good. All of this information suggests that Fazlin's OA-related pain is primarily nociceptive and she was therefore a good candidate for a total knee arthroplasty which targeted the peripheral mechanisms contributing to her pain.

In the analysis below, we are going to specifically discuss the mechanisms contributing to Fazlin's pain *after* her surgery. If you are wanting to refresh your knowledge of the mechanisms of OA-related pain, go back to Section 2, Chapter 3 for Howard's story.

Peripheral nervous system

Surgery clearly results in tissue damage and an inflammatory response with associated firing of peripheral nociceptors and firing of neurons which would have been cut during the procedure (6). Not only will there be inflammatory mediators from the tissue damage, but in Fazlin's situation there would have been inflammation present prior to the surgery. In addition to the inflammation from the tissue processes, there will also be neurogenic inflammation from the backfiring (axonal and dorsal root reflexes) of the nociceptors.

Peripheral nociception will contribute to Fazlin's pain, not only from the surgery, but from the preexisting condition driving inflammation.

In addition to nociceptors firing due to inflammation, there will also be nociception from damage to the nerves themselves. It is inevitable that nerves will be cut or damaged in the process of a joint replacement. Review Section 1 to remind yourself of the effect on nerve function when there is a lesion of a nerve – spontaneous ectopic firing which further increases sensitisation.

All of this inflammation and activity is going to lead to peripheral sensitisation. There will be primary hyperalgesia, as the silent peripheral nociceptors become activated, and all the nociceptors lower their firing thresholds and increase their responsiveness to stimulation. During the inflammatory phase, especially in the first three days when there is an inflammatory peak, Fazlin is likely to have pain at rest, as well as pain on movement (6). As her healing progresses through the inflammatory phase into the regeneration phase, her pain at rest should reduce and she will mostly experience pain on movement as a result of this normal sensitisation. All of this means that after her surgery, relatively little mechanical or chemical stimulus will result in nociception and so the peripheral nervous system needs to be targeted in the treatment plan.

Spinal cord

With the barrage of nociception coming in from the periphery, both from the OA prior to surgery and as a result of the surgery affecting the tissues and the nerves, the second order neurons in Fazlin's spinal cord will also be sensitised (6). Fazlin will be experiencing the signs and symptoms of spinal cord sensitisation – namely, allodynia and secondary hyperalgesia reflecting the lowered firing threshold, increased receptor field size and increased responsiveness of the second order neurons.

Remember that Fazlin has also had pain for many years and this might contribute to a pro-inflammatory profile in her spinal cord. The years of nociceptive activity may have activated glial cells in the spinal cord which would have responded by releasing more pro-inflammatory cytokines such as TNF-α and IL-1β into the synapse. This would lead to even more sensitisation.

Brain

Fazlin was in pain before her surgery and once conscious after her surgery she is bound to have pain again, reminding us that pain is a conscious construct of the brain in response to perception of threat. Having had pain for years means that it is possible that Fazlin's brain has "learnt" pain really well, that her brain fires this knee pain neural network very efficiently. However, Fazlin has also learnt over the years how to manage her pain and her life. She has many interests and engages widely in activities. Although she is retired she has kept herself occupied and has purpose, and Fazlin clearly has a good support structure. All of these factors increase her resilience and can contribute to decreasing her pain.

Fazlin has had pain for many years and her brain will have "learnt" this pain-firing pattern well. Her brain is wired to protect her knee!

Fazlin is very optimistic about having surgery. As you read on, you will see that she has asked for help with her leg before and understood that it was too soon to consider an operation. Now she feels it is time, and she is pleased that the doctors agree with her. Fazlin's goal is to walk again and she is keen to work with everyone in the team to get going again.

Synergistic systems

Fazlin is healthy, and busy and has a good support structure and a purposeful life. She sleeps well, and she has no comorbidities suggesting that none of her synergistic systems were contributing to pain before her surgery. In the postoperative period it will be important to ensure that she continues to sleep well and that she does not develop any complications which may upregulate the immune, endocrine or autonomic systems.

"I need to fix my leg!"

> *I told the doctor "I need to fix my leg!" I won't be able with this problem to go to the toilet alone maybe in a year's time. I explained everything. She took an x-ray and there she sees no, but this knee needs to be seen to. She took all the information and on the smartphone she sent it to GSH. In a month I got an appointment to come see them at GSH. They do the x-rays and they say to me – "I'm going to do your leg because its going to help you in the long run." They can see the polio leg can't help me. I remember that 10 years ago they said when I couldn't walk then they would help.*

Postoperative pain assessment

Pain assessment begins in the recovery room as soon as the person becomes conscious and is able to respond. We must remember that the transition from being unconscious to being fully conscious can take some time. It is not unusual for someone to say that they have no pain when they are first asked, only to complain of severe pain moments later as they become fully conscious! As Fazlin progressed through her postoperative recovery period her pain assessment would have become more in-depth. However, in the initial stages it would start with the simple questions: "Do you have any pain?" and "On a scale of 0-10 how severe is it?". This pain assessment must be documented every time it is conducted.

Once Fazlin had been transferred to the ward, her pain was assessed again when her vital signs were recorded. In postoperative management it is helpful to assess pain every time vital signs are taken to ensure that regular monitoring and documentation of pain occurs. The pain assessment should now become more in depth, paying particular attention to how much pain is interfering with function and her ability to mobilise, and what worrying thoughts she might be having about her pain. In Table 5.4 below, we have highlighted the parts of the "O, P, Q, R, S, T, U, V, W" of pain which are important to assess in the postoperative period.

Table 5.4: The priorities of assessment in the postoperative period

Gather information on the...	Examples of questions to ask	How will you use this information?
Provoking and palliating (easing) activities	What makes the pain feel better and worse?	This helps to clarify the mechanisms and evaluate whether the multimodal analgesics are being effective.
Quality of the pain	Can you describe your pain?	The quality also helps in the clinical reasoning of the mechanisms of the pain.
Region or radiation	Where is the pain? Does the pain spread? Where to?	Provides information for identifying mechanisms in the PNS (discrete area, dermatome, or nerve distribution), SC (referral within a spinal segment), or brain (homuncular referral).
Severity	How severe is your pain right now? How severe is your pain at its worst? How severe is your pain when you need to move and get out of bed? Is pain interfering with your sleeping?	It is critically important to assess severity at rest, but ALSO with movement. It is imperative that pain does not interfere with mobilisation.
Treatment	How much relief are you getting from the medicines we are giving you? Are you feeling nauseous or having any other side effects?	Evaluate effectiveness of multimodal analgesia and assess for side effects to facilitate optimal management.
What else?	How are you feeling about your operation? Is anything worrying you? Are you worried about anything relating to going home?	Helpful to assess threat factors which may be increasing risk of pain.

Fazlin gets a new knee

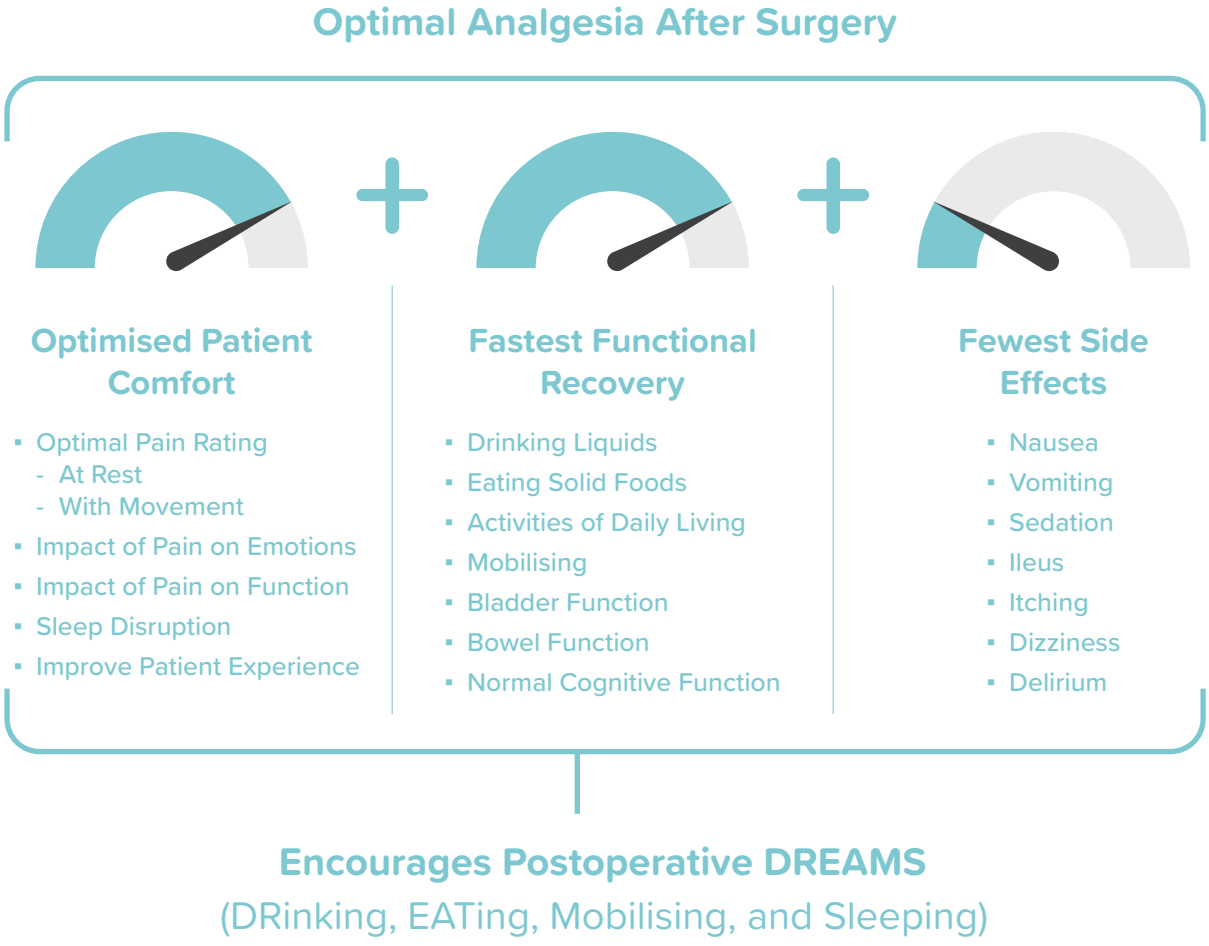
Just a month later they called me to come and have the operation. I was so surprised! I came and they did the operation. I'm so glad – its almost like a dream come true. I'm excited that I've now had an extension to be able to help myself.

Now I've had the operation. They managed the pain very well. Yesterday after the operation I didn't feel any pain because they manage it so nice, beautiful. Its amazing! I can't explain how amazing the doctors are. There is a doctor for everything and in the morning the doctor comes to see if you have pain. I had physiotherapy this morning and I sat on the edge of the bed. It was stiff, and a little bit sore but that's part of the game! Its gonna be sore but it's for myself – you can't get everything just like that, you have to help yourself.

Perioperative pain management

The aim of perioperative pain management is to provide 'optimal analgesia' after surgery (62), with the goal of ensuring that comfort is optimised (their pain is controlled) with the fewest side effects possible (particularly opioid-related side-effects). By achieving optimal pain control with minimal side effects we are creating the best possible environment for functional recovery (mobilisation) after surgery. In practical terms we want the person who has had surgery to be DRinking, EAting and Mobilising (DREAMing – see Fig 5.5) (63), and this is best achieved when multidisciplinary teams share mutual goals for the delivery of care.

Figure 5.5: Optimal Analgesia after surgery



DEEP DIVE

Enhanced recovery after surgery (ERAS)

More than twenty years ago, Henrik Kehlet, a Danish surgeon started to work on ways to enhance people's recovery after surgery (ERAS) by focusing on postoperative pathophysiology and rehabilitation (64). This work led to the development of enhanced recovery pathways (ERPs) which have been adopted as standard care in most surgical specialities (www.erassociety.org) in high income countries (HICs), including for total hip and total knee arthroplasties (65).

ERPs aim to optimise people's postoperative recovery by restoring normal body homeostasis as quickly as possible. This approach means that the detrimental effects of the neuroendocrine, hypermetabolic and inflammatory responses to surgery (e.g., pain, cardiopulmonary stress, gastrointestinal paralysis, cerebral dysfunction, thromboembolic events, infection, muscle degeneration and fatigue) are reduced. In practice this involves targeting each phase of the perioperative period (preoperative, intraoperative and postoperative, respectively) with evidence-based care principles to reduce injury, pain and stress. ERPs can streamline the work of healthcare professionals and lead to improved quality of perioperative care and clinical outcomes including shortened length of hospital stay (66, 67).

Working as a team in an ERP, rather than in independent silos, creates transparency and facilitates the relevant feedback on the service provided which is so necessary for continual improvement. As we said earlier in the book, pain care takes a jazz band! This applies to perioperative care too.

Preoperative pain management approach

The purpose of performing a TKA is to provide pain relief in the affected joint to improve the person's ability to ambulate, and with that, improve their quality of life. However, we know from our South African national audits that 80% of people who have had TKA will experience episodes of moderate to severe pain during activity on the first and second day after surgery, which, 12 months later, is still present in 12% of people. Although these results are better than international data, where up to 20% of people undergoing TKA suffer from persistent postsurgical pain (PPSP) (68), it is still a reminder to counsel people considering this surgery (and any surgery) on the short- and long-term risks associated with the operation before performing the surgery.

80% of people who have had TKA will experience episodes of moderate to severe pain during activity on the first and second day after surgery, which, 12 months later, is still present in 12% of people.

Thus, the preoperative period is a 'window of opportunity' to educate people on their perioperative journey ahead, focusing on the risk of postoperative pain (this is not a 'pain-free' surgery, but we aim to make it tolerable) and the importance of early mobilisation (despite pain/discomfort in the operated joint). The aim is to empower people to play an active role in their recovery process and align their expectations with realistic surgical short- and long-term outcomes. This can be executed through multidisciplinary interactive 'joint classes' or by providing educational pamphlets and/or WhatsApp videos (http://www.youtube.com/@BetterCareBundle).

During your preoperative interaction with the person awaiting a primary TKA, you also need to identify modifiable risk factors for postsurgical morbidity and address them in a timely fashion.

Risk profiles for persistent postsurgical pain:

Ideally, people at risk of developing PPSP should be identified early to afford timely presurgical psychological interventions, integrative therapies, physiotherapy and preoperative opioid tapering. Once they have had their operation, it is useful for the team to have a heightened focus on postoperative pain control (not a catastrophising focus!) to reduce time spent in severe pain as the amount of time someone spends in severe pain is clearly linked to the development of PPSP. People who are at risk of PPSP will benefit substantially from additional in-hospital and post-discharge follow-up (69).

Table 5.5: Preoperative risk factors for persistent postsurgical pain (PPSP)

Risk factor	Descriptor	Method of screening or assessing
Psychosocial characteristics (70)		
Pain catastrophising – exaggerated fear about pain	An overly negative response to or anticipation of pain with three elements: magnification, rumination and helplessness	Pain Catastrophising Scale
Poor coping mechanisms	Disabled by their pain	Pain Self-efficacy questionnaire or any other self-efficacy tool or the WOMAC or other tool to assess disability
Mental health (depression/anxiety)	Depression and anxiety	PHQ-4
Pre-existing pain (71)		
Long-standing severe joint pain	Chronic pain, present on most days for more than 3 months	History taking to establish timeline
Multiple joint pain	Suggestive of nociplastic mechanisms	Brief Pain Inventory body chart
Neuropathic pain-like symptoms	e.g. burning, shooting, electric shock-like pain, allodynia and hyperalgesia	DN4
Medication (72)		
Chronic opioid use	Screen for all opioids	History taking to establish what analgesia has been used, what dosages, and what effect is obtained from the medication

Intraoperative multimodal analgesia

Multimodal analgesic strategies should be used to optimise postoperative pain relief and reduce opioid use and opioid-related adverse events, to facilitate postoperative recovery (73). The following procedure-specific multimodal analgesic methods are recommended for TKA and were used for Fazlin (74, 75):

- **Neuraxial anaesthesia (NA)**
  - Provided there are no contraindications, a primary NA technique (which may include intrathecal opioids) is preferred to general anaesthesia as there are several positive benefits important for post-TKA outcomes (76). Importantly, in the immediate postoperative period, pain is well controlled (unless the surgery outlasts the NA).
- **Glucocorticoids (a class of corticosteroid anti-inflammatory drug)**
  - A dose of ≥10 mg dexamethasone (intravenous) is recommended in the PROSPECT guidelines (75). Dosages as high as 1mg/kg dexamethasone have been used experimentally in people classified as high pain responders undergoing TKA (77). It must be noted that studies advocating glucocorticoid use have all been performed in high income countries where the demographics (low incidence of infectious diseases) and surgical services (short surgical time and sterile surgical theatres) might differ from your setting. Thus, we advise that you discuss the use of glucocorticoids and appropriate doses with colleagues in your setting to reach consensus on best practice in context.
- **Peripheral nerve block (PNB) or local infiltration analgesia (LIA)**
  - Ultrasound-guided, single-shot adductor canal block (ACB) performed either before or after the surgery; using 20 ml 0.25% bupivacaine (a local anaesthetic) (watch a video on this here: https://youtu.be/M464d7S1htc).
  - Local infiltration analgesia (LIA) can be performed by the surgeon at the end of the procedure. A 50-100 ml local anaesthetic mix is usually used, according to local guidelines.
- **Non-Steroid Anti-inflammatory Drugs (NSAIDs)**
  - A short course of NSAIDs should be initiated during surgery (either via a rectal suppository like 100 mg Indomethacin or via intravenous agent like 40 mg Parecoxib), if no contraindications exist. Refer back to the NSAID decision tool we provided in the introduction to this section to assist in evaluating risk.
- **Paracetamol**
  - Although a weak analgesic, paracetamol still has an additive analgesic effect with a low risk profile. Ideally 1g paracetamol can be given orally preoperatively. If preoperative administration has not occurred, then a standard dose of 1g IV is recommended intraoperatively. As the foundation analgesic, paracetamol should then be continued routinely postoperatively by the clock.

Postoperative pain management

The goal of a postoperative analgesic strategy is to get the person 'DREAMing', which can be accomplished by continuing opioid-sparing multimodal analgesia. As we hear from Fazlin, she was doing well with her DREAMing. Fazlin was managed with round-the-clock NSAIDs and paracetamol which served as a baseline treatment. She also received oral tramadol of 50-100mg, 6-8 hourly. However, some people

do not feel well with tramadol and suffer from nausea which outweighs the pain relief benefit. In these situations, people may choose to not use the tramadol if they feel their pain is adequately controlled. Fazlin had minimal pain after her surgery and coped well with the paracetamol and tramadol which meant that stronger opioids were not needed.

Movement is important treatment for postoperative pain targeting peripheral and central mechanisms.

If Fazlin had had moderate to severe pain in the first days after her surgery despite all the above multimodal analgesia, IV/IM morphine could be used. Patient controlled analgesia (PCA) (usually morphine or fentanyl) is an option when people suffer from poorly controlled pain after surgery or in those who have been identified as being at risk of having a high pain response. However, PCAs are expensive, and they require extra supervision/maintenance. A PCA can also hinder the person's ability to mobilise as they will have an IV line in situ.

Mobilising (remember from DREAMing) is a critical part of treating postoperative pain and reducing the risk of complications arising from bedrest. This means that the physiotherapy team should be involved as early as possible in the postoperative management. Physiotherapists and nurses working together with the person who has pain can facilitate their getting up out of bed for all meals and mobilising to the bathroom. Movement is important as it improves circulation and targets peripheral nociceptive mechanisms contributing to pain. Movement also targets central nervous system mechanisms to reduce pain. It is important to ensure that analgesic medications have been used appropriately prior to mobilising in the postoperative period and a PCA is being used, for the physiotherapist and the person with pain to work together to use it optimally during the mobilisation session.

Physiotherapists are also trained to be able to use TENS and ice to manage pain with the goal of facilitating movement. As we discussed in Section 1, TENS can target pain mechanisms by providing competing input from the periphery at the spinal cord level which used at a dose of 100Hz; or it can be used at a low dose of <10Hz to stimulate descending noxious inhibitory control (78). Ice can also be used to manage pain by targeting the peripheral nervous system as when the temperature of a nociceptor reaches 4°C, it stops firing entirely. Fazlin was doing well with her analgesic regimen and pain was not interfering with her ability to mobilise, so these additional modalities were not needed here.

DEEP DIVE

The first dressing change

Many people report that their pain was well managed, until the first dressing change. We can hypothesize that this is because of an increase in threat when the knee and the wound are visualised. Have you ever seen the wound from a total knee arthroplasty (or other major surgery) at the first dressing change? The dressing often has blood on it, sometimes it sticks to the skin on removal. The wound will be inflamed (as it should be for normal healing processes!), there is redness, swelling and of course evidence of surgery and stitches or staples to close the wound. Seeing all of these things may make the person who has had the operation feel frightened. It can be threatening to see your own body like this. This increase in perceived threat, may indeed result in an increase in pain!

How can we manage this? It is helpful to explain to the person who has had the operation about what you expect to see when the dressing change is done. Explaining what you expect the wound to look lie when the dressing is removed is helpful. Explaining that it is normal, and actually encouraging to see signs of inflammation as these are indications that the body is doing its job of healing, can reduce the sense of threat and reduce pain!

Discharge planning

Prior to discharge it will be helpful for Fazlin to learn about what pain medication she will be taking home with her. It is likely that she will be discharged with paracetamol and an NSAID which should be taken routinely with tramadol to be used if her pain worsens. She needs to be educated to take her medication regularly and how to use analgesia that has been prescribed for breakthrough pain. It is also useful for Fazlin to learn about tissue healing times and for her to understand that during the first two weeks there will be inflammation and that this inflammation may contribute to pain. This is why she is being sent home with NSAIDs for 7-10 days. It may also be useful for Fazlin to learn about using ice and regular exercise to reduce her pain and optimise her recovery.

Finally, it will be useful for Fazlin to learn about the first 6 weeks of healing to the end of the tissue regeneration phase and into the tissue remodelling phase up to 3 months. It will also be important for her to learn about how her rehabilitation will link to these phases and how she can continue to use analgesia to manage pain before doing her rehabilitation exercises or attending physiotherapy. Fazlin has done very well from her total knee replacement to this point and with the above information she will be able to continue her recovery and return to living a full life.

Fazlin says thank you

> *It is the most wonderful thing to be a doctor. To help other people is a blessing and a privilege. Sometimes people don't tell you thank you. They never have the chance to say thank you doctor, but in your heart, you always bless that doctor!?*

Lessons learnt

Prior to her surgery, Fazlin's pain was primarily nociceptive meaning that she was likely to recover well. The team used multimodal perioperative strategies to manage her pain and this made a significant difference to pain and recovery.

Fazlin knew that recovering from a total knee replacement can be painful, however she had been well prepared and was engaged by the pain management team so that she felt she knew what to expect and how to work with her team to manage her pain. Ensuring that the person having surgery understands that postoperative pain is normal but can be managed, and that they understand how to manage their pain is valuable.

Aim to get the person who has had surgery DREAMing after their surgery.

5 Thoracotomy for hydatid cysts

Busisiwe can't breathe

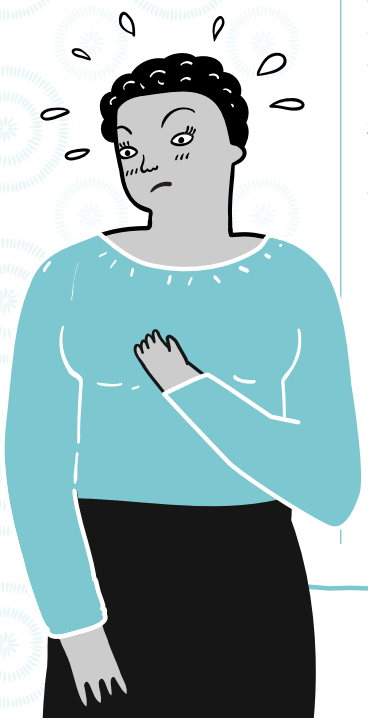
Romy Parker
Alma de Vaal
Tracey Hargreaves
Busisiwe Hewe-Ngcatshe

Introduction

My name is Busisiwe, my surname is Hewe-Ngcatshe, a double-barrelled surname because I'm married. I am coming from the Eastern Cape in King Williamstown - that's where I was born. Then I came to Cape Town when I was 8 years old for school. I went to primary school in Gugulethu, and I went to high school in Philippi. I passed my matric in 2005. Only my mother is living, and she didn't have money for me to study more so I had to work, I had piece work. Then I went to work at Claremont from 2008 at the Interpark. From there I did a course for home base caring. I didn't have money to further my studies, I needed more science, but I didn't have money for more science. So, I continued to work.

In 2014 I resigned there and started working at Shoprite and now I work at Builders'. I'm married and I live in Philippi for now, but I want to live in a high place with a view! I have two beautiful girls who are 12 and 6 years old and they are both at school. My husband works in another company. We have a lovely happy family.

In May I had tonsils, so I went to the doctor to give me something. But I didn't heal well, so went to another doctor. While I was healing from the tonsils, on a Saturday morning I woke up to make myself some food. You see I wasn't eating while I had the tonsils, I needed soft food. As I was walking from my room, I discovered that I was short of breath. Then I was coughing. By the time I reached the dining area I couldn't walk, I couldn't talk, I was coughing it was like my breath just went away. I was very scared. Fortunately, my husband and the children were there. 10-15 minutes I was struggling to breath, I was trying to get my breathing right. Eventually it came down and I could breathe, but not the same as before. So, during the day I was at home, I couldn't go anywhere because I was struggling to breathe. I couldn't think of going to the hospital or the clinic because it was Saturday and I had just been to the doctor. So, I wanted to see what is this? I stayed at home the whole day. At 6 o'clock in the evening I started coughing, I started losing my breath. My husband was not there, my children were not there, I was alone. Then I took my phone and phoned my cousin who is living in the area to find my husband. She called my husband, he was at a funeral, and they came around about 8 o'clock. He said we are going to the hospital because your breathing is the same as it was in the morning. And I was feeling pain with the breathing, in the chest, it was like I was dying. I don't know how to die but it was like they were taking my breath away. My husband insisted we go to hospital, I said no, I am afraid of hospitals, but eventually we went to the hospital.



While going to the hospital my breathing was coming down. When they checked me at the hospital there was nothing wrong, the pulse and everything, the pressure was right. They didn't see anything wrong! Up until - the one doctor saw the x-ray. The doctor came and said I need to double check you because there is something on your lungs. I never had anything with my lungs, I never struggled with my lungs! So, he came with the ultrasound machine, and he was like, here on the left side there are two things there. What is that? The doctor couldn't tell me. He said to wait here, and they would explain it. And then they admit me – just like that. The pain was better by now, I don't want to lie. They gave me a bed, but then the same pain in the chest started and pain in the lung on the left side. A very sharp pain, I could not take it. The nurses gave me pain pills, but it didn't help.

They admitted me, for 4 days I stayed there. They were doing investigations to see what it was. The next day the doctor said I have something in my lungs like granules. They asked if I had been in the Eastern Cape because the disease is more common there. It comes from the worm, from the liver of the goats and pigs and sheep. I was very shocked because it was long long ago since I was in the Eastern Cape – I have been here for about 20 years. Maybe it's been there all the time and slowly growing. After that they told me that they can't give the final say of what they can do about the lungs, they must ask the doctors at the referral hospital what is the best – to drain or do the operation. So, they discharged me to wait for the explanation from the referral hospital.

Epidemiology of hydatid cysts

Busisiwe has pulmonary hydatid disease caused by the larvae of the Echinococcus tapeworm (79). The adult tapeworm lives in the intestine of carnivores which have not been regularly dewormed, primarily domestic, and wild dogs, which are referred to as the definitive hosts of this worm. The worm releases its eggs into the intestine, and these are then passed in the dogs' faeces. Domestic animals such as pigs, sheep, goats, and cattle are called intermediate hosts, because they do not host the adult tapeworm but actually host the worm in its intermediate stages of being an egg and a larva. The domestic animals become infected by ingesting or eating the tapeworm eggs. Humans are often referred to as accidental intermediate hosts (80). Once the egg has been ingested by a human or a domestic animal, it releases larvae which then circulate in the blood and lymphatic system. These circulating larvae settle in the tissues of organs where they form cysts which slowly grow larger over time. The most common sites of these cysts are in the liver (70%) and in the lungs (20%) as in Busisiwe's situation (81).

Hydatid disease is caused by the larvae of the Echinococcus tapeworm. It is not unusual for symptoms to appear many years after exposure to the tapeworm.

Just as we hear from Busisiwe, it is not unusual for people to present with symptoms many years after exposure to the tapeworm as the cysts develop slowly in tissues with high levels of elasticity (79). The most common way that people may become exposed to infection is through farming where livestock and dogs are in close contact and where home-slaughtering means that the dogs are likely to ingest raw, infected meat of intermediate hosts (82). It is likely that Busisiwe was accidentally exposed as a child and the cysts have been slowly developing for years. In South Africa, the prevalence of these cysts appears to be highest in the Eastern and Western Cape provinces (82). Busisiwe's symptoms are typical of hydatid cysts which might be causing compression or damage to bronchi and lung tissue with coughing, shortness of breath and chest pain. In addition, people may also present with haemoptysis (coughing blood), and feeling generally unwell with nausea and vomiting (79). Imaging using X-rays and ultrasound allows the healthcare professional to identify the presence of a cyst with typical characteristics. In addition, blood tests can show elevated levels of echinococcal antibodies.

Busisiwe waits for help

By then I was feeling a lot of pain, a sharp one. And the breathing wasn't the same. The breathing was painful inside. Very painful to breath. Then I went home. By the time I was going home there was a lot of pain. That day I couldn't sleep, and I couldn't go back to the hospital, I know there was something in my lungs and I must wait for the doctors. I went home with pills, but they didn't help, and the pain didn't stop. I was discharged on a Thursday, the sharp pains carried on for two days and I couldn't sleep. By Sunday the pain was better.

Then we got a message to come to the referral hospital. There was pain up till then, but not that much. We came to the hospital in mid-May. The doctors showed us the x-ray and tell us we have to open you and take them out, we can't drain them. I was like, YOH! I'm not ready for this! I was thinking of the pains, I know the pain that I have but now I am thinking of the pain of the cuts and removing and everything. I will feel the pain. But I couldn't say no, so I said, OK its fine we can do the operation. They gave me two weeks to let it ease, to rest.

In those two weeks I was working, but I had pain. I had no choice but to work because I need the money. I was working but I was experiencing cough and a lot of pain, but I was working. The pills didn't help. They gave me pills to kill the worms on the inside but not for the pain. I was experiencing a lot of coughs; it was coming from the chest, and it was very painful. It doesn't help to drink anything for the cough.

Mechanisms of pain from the cyst

How is it possible that Busisiwe had cysts slowly growing in her lungs for such a long time with no pain or other symptoms at all? As we pointed out above, the lungs are very elastic and can often compensate for mechanical interference like a cyst without affecting their function. But no pain? Lung tissue itself is poorly innervated, and the majority of the nerves in the lungs are part of the autonomic nervous system via the vagus nerve which carries information to and from the brain to the lungs. There aren't many nociceptors (nerves to send warnings about actual or potential tissue damage) in the lung tissue itself (83). Busisiwe probably had no pain for such a long period of time because the cysts were only affecting the lung tissue. When the cysts became large enough to affect other tissue, perhaps her bronchi or pleura, then she started to experience pain and this pain quickly got worse! Busisiwe was suffering from visceral nociceptive pain before she had her surgery.

Visceral nociceptive pain in the lungs often arises late in a disease process as lung tissue is poorly innervated.

Peripheral nervous system

The cysts may have started to irritate (mechanically or chemically) the pleurae of the lung. The pleurae have many nociceptors which are sensitive to inflammation and infection (8, 83). When the pleural nociceptors are stimulated people experience a sharp stabbing sensation in the chest which typically feels worse with a deep breath or a cough. As the nociceptors keep firing, they would have become sensitised, with lowered firing thresholds and increased responsiveness to stimulation. The viscera have more silent nociceptors than somatic tissues, this means that when peripheral sensitisation occurs there is a rapid increase in nociception and an increase in pain (83). Once the sensitisation process started, it was easier and easier for Busisiwe to generate nociception and her pain rapidly increased.

The cysts may also have become large enough to disrupt the bronchi. This might result in bronchospasm, constriction of the bronchial muscles which reduce the size of the bronchi and make the chest feel tight and breathing feel difficult. This feeling of having a tight chest and difficulty breathing would have been transmitted via the phrenic and vagus nerves. In Busisiwe not only might this have contributed to pain directly (83), but this would also have activated the synergistic systems (autonomic nervous system, in particular the sympathetic branch; and the endocrine system in response to stress).

Spinal cord

Visceral spinal cord mechanisms are more complex than somatic mechanisms with the sensory innervation involving both the sympathetic and parasympathetic nerves (83). In the spinal cord, visceral afferent nerves converge with somatic afferent nerves in the dorsal horn at the spinal cord level where the nerves enter the spinal canal. However, the visceral nerves can also terminate up to 10 spinal segments above or below their entry point e.g. if the visceral nerve enters the spinal canal at L1 it may extend up to T5 and down to L5 (83). This helps us to understand the extensive, if often vague, referral of visceral pain. The spread and overlap of nerves from the viscera into the spinal cord also helps us to understand the spread of sensitisation across organs. Busisiwe's pain started in a localised area but quickly spread to her whole chest.

Brain

Busisiwe's brain is clearly involved here as she is experiencing pain. Interestingly nociception from visceral structures activates a wider number of brain areas than nociception from somatic structures (83). There is greater activation of the cerebellum in response to visceral nociception, perhaps not surprising given the involvement of both sympathetic and parasympathetic fibres. The areas of the cortex with the most activity when someone has visceral pain include the prefrontal cortex, the primary and secondary somatosensory cortices, the anterior cingulate cortex – all areas that are also active with somatic pain. However, there are distinct differences in the portions of the anterior cingulate and the prefrontal cortices that are active with visceral nociception which may explain why people with visceral pain have greater emotional-affective components of pain, with greater suffering, larger cognitive impact making decisions difficult, and generalised reduced tone (83). We can clearly hear how distressed Busisiwe was by her pain.

Visceral pain causes significant suffering with notable cognitive impact due to high levels of activation of the anterior cingulate and prefrontal cortices.

Synergistic systems

The synergistic systems were clearly contributing to Busisiwe's pain, both through the nociceptive processes and because of the involvement of the phrenic and vagus nerves – both nerves are autonomic. Throughout the above discussion on the peripheral nervous system, spinal cord and brain, the role of the autonomic nervous system has been emphasised. Not only would this have contributed to her acute pain, but ongoing stimulus may result in dysautonomia – dysregulation between the sympathetic and parasympathetic systems which can then further contribute to pain.

Not only would the autonomic system be involved but Busisiwe's immune system will be activated by the presence of the echinococcus. It is likely that she is expressing more proinflammatory cytokines which will upregulate both the peripheral and central nociceptive processes. Finally, throughout her story we can sense how distressed Busisiwe was from her symptoms and her fear of attending the hospital. The fear suggests to us that her endocrine system would also be contributing to nociception through the release of cortisol (84).

Busisiwe has her first surgery

I came back to the hospital after two weeks and I was admitted for the first. Then the first operation. YOH! There was a lot of pains! I don't want to lie! I didn't think I could survive, because there was a lot of pain. When I had the first pain with coughing at the beginning when I was first sick, I thought I was dying, but this pain now, this was much worse! I didn't think I could survive the operation pain. I was experiencing the cut, the tubes the drains on my left side and I had to cough. The cyst was out now, and I had to cough to get it out. So, every time I'm coughing, I am coughing, pain from the cut and the tubes. Every day I was coughing and crying. It was not nice! I prayed a lot, every time. I don't know how many days, how many hours, I was praying and crying, please Lord, let this pain be less. The praying helped. It was not easy that first operation. I was experiencing a lot, a lot of pain, I don't want to lie. The pain was worse than anything, I couldn't even want it for my enemy. The pain was too much. Now ever since then, if you say you have pain somewhere I feel for you, because I know the pain.

After five days from the operation, I went home. They sent me home with pills for the pain. They were only helping for me to sleep, not for the pain, cause when I coughed! After, two weeks the pain was now coming down, it was lesser. After two weeks I came to the clinic, and they took out the stitches and staples. Then I must come back for the second operation the next Monday. I came, but there were a lot of emergencies so they sent us back home, they couldn't operate!

Busisiwe had a thoracotomy

Thoracotomies are one of the most painful types of surgical procedures performed. The literature encourages the use of minimally invasive techniques which are taught in many academic centres. The use of minimally invasive techniques means that, paravertebral blocks, fascial pain blocks and wound infusion catheters are increasingly used, with good success, needing less nursing care. All-in-all, these approaches will need less resources, as people will be able to go directly to the ward postoperatively and won't need high care. However, most of the thoracic surgeries performed in South Africa still use an open surgical approach. This means that a large incision is made, and that the thoracic cavity must be splinted open to allow access. The splinting can cause tissue damage to the intercostal muscles and injury to the parietal pleura all contributing to postoperative pain.

About one third of people who have a thoracotomy develop PPSP, specifically called post-thoracotomy pain syndrome (85, 86). Post-thoracotomy pain may have both neuropathic and visceral components. This chronic pain is postulated to be caused by (i) the incision through the thoraco-abdominal muscles; (ii) inflammation of the lung parenchyma and pleura; or (iii) pressure on the neurovascular bundle under each rib (85). Other causes of post-thoracotomy pain include (iv) damage of the long thoracic nerve from the initial incision or (v) the need to remove a rib for surgical access (86).

Thoracic surgery also negatively influences the mechanics of respiration which may then lead to postoperative pulmonary complications. The mechanics of respiration will be affected both by the physical damage to the tissues and by pain. Pain on breathing may result in the person with pain splinting their hemithorax (keeping it still), which means that they then take inadequate tidal volumes as they are not expanding their lungs adequately with each breath. The splinting also impairs coughing and decreases the person's ability to clear secretions from the lungs leading to atelectasis, shunting and hypoxemia. This poses a risk for pneumonia and wound sepsis. These respiratory complications are more likely to occur when people are receiving inadequate analgesia (87).

DON'T MISS THIS

Thoracotomies are red flags – they predispose people to central sensitization

All of the mechanisms contributing to pain due to thoracic surgery emphasise why guidelines should be in place to ensure the appropriate use of non-pharmacological and pharmacological treatments for every person having this surgery. Adequate management of their pain is essential for a good outcome. By now we know a multimodal approach is the way to go. It is opioid sparing and targets multiple different receptors and mechanisms, all working together to manage pain effectively.

The ideal multimodal approach for an open thoracotomy should include:

- Education of the person with pain to ensure they understand their treatment choices and how to use non-pharmacological approaches.
- A regional anaesthetic technique:
  - An epidural still remains the gold standard, however this procedure carries high risk with high reward.
  - A paravertebral block (PVB) or an erector spinae block (ESB), serratus anterior blocks (SAPB) and a wound infusion catheter can be placed at the end of surgery with lower levels of risk.
- Paracetamol on the clock every 6 hours
- NSAIDS via oral/rectal/IV routes by-the-clock
- Adjuncts such as ketamine infusions intraoperatively are useful to decrease opioid requirements.
- Opioids are very effective particularly when delivered via patient controlled analgesia (PCA) or via a continuous infusion. PCA or continuous infusion should be used for the first 24-72 hours with treatment titrated down via the use of oral formulations or regular intramuscular injections for 3-5 days. Opioids should be weaned as soon as possible as they are responsible for the most undesired side effects. People should not be discharged home on opioids.

Mechanisms of Busisiwe's postoperative pain

Once Busisiwe had her surgery, she now had acute nociceptive (somatic), neuropathic and visceral pain with both peripheral and central sensitisation (6). Thoracic surgery results in stimulation of both somatic and visceral nociceptors (88). Somatic nociceptors will be stimulated from the incision of the skin, retraction of her ribs, and the splitting of muscles to allow access to the lungs. Visceral nociceptors will be stimulated from the incision or damage of the pleura and incisions of the bronchi. While the somatic nociceptors will transmit information to the spinal cord, visceral afferents travel via the phrenic and vagus nerves meaning that the autonomic nervous system is also involved. Therefore, Busisiwe's system has been primed for pain prior to surgery, and the surgical procedure has now stimulated the same nerves which were already activated by the presence of the hydatid cysts. Poor Busisiwe has been primed for pain!

Peripheral nervous system

The process of surgery, cutting through tissues to access the cysts would result in stimulation of the C- and Aδ-fibres in the cut tissues which would then become sensitised (6). This could result in Busisiwe experiencing pain with primary hyperalgesia once she was conscious.

Not only would the fibres in the cut tissue be stimulated and sensitised, but some fibres would also be cut, resulting in an additional neuropathic process. Lesion of the peripheral nerves will result in spontaneous ectopic firing, further upregulating sensitisation. When the C-fibres in muscles are cut during surgery,

the spontaneous ectopic firing not only contributes to spontaneous pain but also results in spontaneous muscle guarding (6). The cut nerves (nerve lesion), often also mean that people have the strange experience of loss of sensation, like numbness to touch and temperature, but have hypersensitivity, like allodynia and dysaesthesia (88).

The sensitisation and spontaneous activity in the peripheral nervous system explain the pain felt at rest at the incision, pain on weight-bearing or movement including breathing and coughing, and primary hyperalgesia to mechanical and heat stimuli. The sensitisation of the peripheral nervous system is linked to inflammatory processes, meaning that these mechanisms contribute significantly to pain in the early postoperative stages during the inflammatory phase of healing.

Spinal cord

We have discussed the range of spinal cord mechanisms which were contributing to Busisiwe's pain before her surgery. Now, with the additional nociception from the surgery, the sensitisation in the spinal cord will increase. In particular, the NMDA receptors are initially sensitised, but recent evidence shows that the AMPA receptors in the spinal cord play a key role in maintaining spinal sensitisation, contributing to ongoing nonevoked pain and hyperalgesia (6).

Pain in the ipsilateral shoulder after a thoracotomy is theorised to be caused by irritation of the phrenic nerve which sensitises the spinal cord further.

Activity in the spinal cord also contributes to referred pain post thoracotomy. Many people who have had a thoracotomy suffer from pain referred to the ipsilateral shoulder (the shoulder on the same side as the incision). You may recall from the earlier discussion of the pain mechanisms from the cysts that visceral nerves terminate several levels above or below their point of entry into the spinal cord. Pain in the shoulder is theorised to be caused by nociceptive stimulation of the phrenic nerve. Phrenic nerve fibres may terminate as high as C3 to C5 resulting in referral of pain to the shoulder (88).

Brain

Clearly Busisiwe's brain is involved, she is in pain. In addition to the mechanisms contributing to her pain preoperatively, she now has additional thoughts and feelings which may have increased her pain. We can hear clearly how worried she was about the surgery. Certainly this is a normal response to the situation but rumination (repetitive thinking or getting stuck worrying about the negative feelings or possible consequences) and anxiety considerably increase pain (89).

Synergistic systems

As we have pointed out in the discussion of peripheral nervous system mechanisms, the autonomic nervous system is a contributor to nociception post thoracotomy. Not only are the phrenic and vagus nerves transmitting nociceptive information, but their stimulation may also affect breathing patterns and increase feelings of breathlessness. Feeling breathless may then make someone feel stressed and anxious resulting in an endocrine response. Pain may also have affected Busisiwe's ability to sleep (and sleeping in a hospital can be difficult too with lots of noise and interruptions). Finally, Busisiwe's immune system was already activated before the surgery, now with the insult of surgery there would be an appropriate immune response. All of these synergistic systems were active before her surgery and would now increase and further drive her pain.

Polypharmacy for pain and parasites

Analgesic medications such as nonsteroidal anti-inflammatory drugs (NSAIDs) and paracetamol may be administered to mitigate pain, but careful consideration should be given to the potential interactions with antiparasitic medications that may also be prescribed. It is important to check what other pharmacological treatments are being used and checking for potential drug interactions prior to prescribing analgesia.

Pain management of Busisiwe's first surgery

Poor Busisiwe had a terrible time after her first surgery which was performed on the left side. As we have heard from Busisiwe, she wasn't well-prepared for the surgery as she doesn't recall being given clear information about what to expect. This means that the opportunity to fully manage her postoperative pain in the preoperative period was missed by the team. On reviewing her notes, when her pain was assessed, it was only documented as mild/moderate/severe. There was no clear documentation of whether her pain was interfering with her mood, her breathing and coughing or her ability to move in bed and mobilise out of bed. All of these aspects are critical to assess in the acute postoperative period to ensure optimal recovery from surgery.

Intraoperative pain management of Busisiwe's first surgery

Once she was in theatre, the anaesthetist inserted an epidural for Busisiwe while she was still awake. This was good practice as awake epidurals are the standard method for insertion because it allows for the best anatomical positioning of the catheter compared to an asleep technique which requires the person to be placed on their side. With the person awake, they are also able to communicate with the team about the onset of paraesthesia. This feedback guides the anaesthetist in administering the procedure and is considered safer (90).

Epidurals are placed prior to surgery so that they can be used for both intraoperative and postoperative analgesia. The dosage of local anaesthesia used needs to be carefully considered by the anaesthetist as the drugs affect motor, sensory and sympathetic fibres. Low concentrations (0.1%) only affect the sensory fibres resulting in analgesia only. Higher concentrations result in muscle relaxation as well as analgesia causing hypotension which may need to be managed with vasopressors and fluid boluses (90).

Busisiwe was given four 5ml bolus doses of the local anaesthetic 0.2% bupivacaine during the surgery. This relatively low dose may have been selected because of the risk of hypotension, but it might not have been sufficient to maintain a desired level of analgesia to reduce nociception during the surgery.

In addition to the local anaesthetic (bupivacaine) administered through her epidural, Busisiwe was also given low doses of morphine through the epidural during her surgery. However, the morphine doses given were sub-therapeutic, a decision which may have been made to reduce the risk of Busisiwe suffering from postoperative side effects like nausea and vomiting (91).

While Busisiwe's intraoperative pain management included some of the important elements of multimodal analgesia, she would have benefited from additional, low-risk treatments. The addition of intraoperative paracetamol, NSAIDs and an adjunct such as ketamine may well have made a significant difference to her postoperative pain (92).

DEEP DIVE

Golden nuggets for a good working epidural!

Epidurals are considered the gold standard analgesic technique for thoracotomies (93). Most of the other regional techniques are considered good alternatives when an epidural is contraindicated, has failed or there is no appropriate postoperative monitored environment for appropriate care. Epidurals are usually kept in place for 48-72hours. This is a distinct advantage over the regional blocks such as the ESB, SAPB or even a paravertebral block which only last for about 6 hours, unless a catheter is placed for a continuous infusion.

People receiving a good working epidural in a monitored environment where haemodynamic parameters and pain can be regularly assessed have lower VAS scores and less opioid requirements (94). Care needs to be taken to reduce the risks associated with insertion (important to ensure there are no contraindications to an epidural) and hypotension both intra- and postoperatively.

These risks require continuous assessment and management. The benefits of epidurals including reducing postoperative pulmonary complications, more rapid mobilisation, less ileus and improved analgesia outweigh the risks, hence this approach being regarded as the 'gold standard' of care (94).

Pearls for making your epidural effective and safe:

1. Ensure you insert it at the correct level - ask the surgeon where the incision will be, typically it will be at the T6/7-T7/8 levels.
2. Don't push the catheter in too deep.
3. Continue with a multimodal analgesic approach with the epidural in situ – an epidural alone is not enough.
4. Combine your epidural with fentanyl or morphine, as these drugs have an additive effect.

Postoperative pain management of Busisiwe's first surgery

Busisiwe arrived in PAHCU (Post Anaesthetic High Care Unit) in the late afternoon after her operation. PAHCU is the recovery area of the theatre complex, and it can be a noisy place, filled with people coming and going with lots of disturbances and no privacy. She was admitted by the junior doctor on duty, and she still had the epidural in situ.

When she was admitted to the PAHCU, the doctor tested her epidural level. Her epidural level was documented at the T4 sensory level (the level of the 4th thoracic vertebra represented by dermatomes). The doctor should also have tested to record the lower level of the epidural, in other words the level at which her feeling returned but there is no record of the lower level noted in her records. An epidural works as a "belt" of analgesia. It has a top level and a bottom level. This is different to a spinal anaesthetic which is a much denser block that only has an upper level. The doctor did record that Busisiwe was comfortable at the time and could move her arms and legs with no other concerns.

On admission to the PAHCU Busisiwe's oxygen saturation was 92% on room air. This should have raised concerns as her oxygen saturation at the start of the surgery was 98%. The drop in oxygen saturation could be an indication that Busisiwe was splinting due to pain resulting in hypoventilation or shallow breathing. The appropriate response to this change in saturation would be to increase her analgesia and/or refer to physiotherapy for respiratory therapy.

Indeed, Busisiwe's analgesia was adjusted. In addition to her ongoing epidural infusion (bupivacaine 0,1% with fentanyl 2ug/ml) at 12 ml/hour, she was given morphine boluses (referred to as rescue analgesia). Unfortunately, it seems that Busisiwe experienced nausea as a side effect of the morphine as she also needed

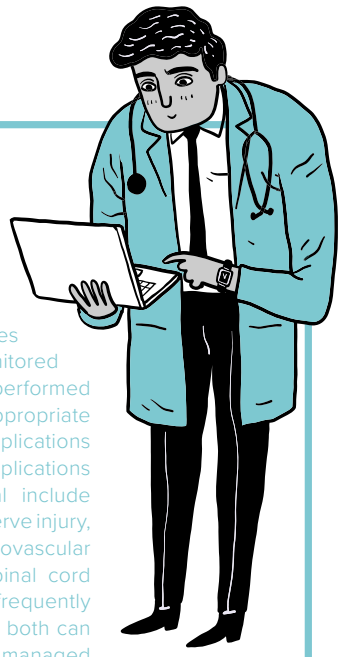
DEEP DIVE

Making the most of an epidural

The benefits of placing the epidural versus the risk of placing one is only seen once the epidural has been in situ for 48-72hours, therefore it is important to ensure that appropriate monitoring is in place for this time. At a minimum, epidurals should stay in situ for at least 48hours, in other words for the peak of the inflammatory phase (94).

Regional anaesthesia using an epidural combined with a multimodal systemic technique allows for an opioid sparing effect. Should someone continue to struggle with pain when they have an epidural in situ, the dosage of medication in the epidural should be adjusted prior to making the decision to use systemic opioids. This approach reduces the risk of side effects from systemic opioids which include ileus, nausea, itching, respiratory depression and dependence (91).

Epidurals are high risk procedures that should be looked after in a monitored environment. However, when performed by trained clinicians in the appropriate environment, the risk of major complications are less than 2 per 100 000 (95). Complications which can occur from an epidural include abscess or haematoma, meningitis, nerve injury, spinal cord ischaemia, fatal cardiovascular collapse (95). Complications like spinal cord injury and epidural haematomas frequently occur due to errors on insertion and both can cause permanent paralysis if not managed appropriately. Regular checking, neuro-observation testing and documentation of an epidural are vital to reduce the risks of these complications (96).



three doses of ondansetron to treat nausea. As suggested in the 'Deep Dive: making the most of an epidural', it may have been more effective to increase the dose (by increasing the concentration or rate of infusion or top-up boluses) of Busisiwe's epidural to improve her pain management and respiration before giving her morphine boluses. In the immediate postoperative period in PAHCU, Busisiwe did not receive any intravenous paracetamol (perfalgan), NSAIDs or ketamine.

Busisiwe's epidural was removed the next morning, which meant that she had it for less than 24 hours. She was then given a PCA (patient-controlled analgesia) which allowed her to take some control over the administration of her analgesia, and she was prescribed oral paracetamol by-the-clock. However, on the pain round later that day, the team noted that she was still struggling with pain and sweating. The team decided to optimise her pain management with further medication. They added morphine intramuscular injections and tramadol 8 hourly.

DON'T MISS THIS

What is patient-controlled analgesia (PCA)?

PCA is commonly used in hospitals and other healthcare settings for managing acute postoperative pain or other types of severe, short-term pain. It allowed Busisiwe to titrate the medication to her own pain levels and needs.

The following day (now 48 hours post-surgery) there was no mention of pain in the doctor's documents. Busisiwe continued to use the PCA and receive oral paracetamol and tramadol with intramuscular morphine for her pain for four days. Unfortunately, on the fourth day, Busisiwe only received one dose of tramadol and paracetamol. Busisiwe stayed in a hospital for one week and she was discharged with paracetamol (1g 6hrly) and tramadol (100mg TDS).

Busisiwe has her second surgery

I came back the next week. Remember I'm still not fully recovered from the first operation, but I have to do it, because I'm still coughing. They admitted me and did the operation. But what I experienced on the second one, it's much better than the first one. The pains are still there. I'm not sure why its better. I think its different medicine. Because on the first one I didn't have all of the medicine I have now. From the first operation I went from theatre to high care. This time around I went from theatre to ICU – and I asked why am I in ICU? The doctor said it was for pain – everything is OK, it was to control the pain in ICU.

It's still painful when I cough but it seems to be better generally. It's very different from the first time. The first time I wouldn't talk to you after two days, this time it's OK. I think I will go home in a few days. I feel like I can go now, it's different to the last time!

"It's very different from the first time. The first time I wouldn't talk to you after two days, this time it's OK. I think I will go home in a few days."

Pain assessment and management of Busisiwe's second surgery

Busisiwe's second thoracotomy was scheduled on the right side a month later. The day before her surgery, Busisiwe was seen by the anaesthetic registrar. This presented an opportunity to educate her on the surgery and how the team would work with her to manage her pain (8). The registrar noted that her last thoracotomy was uneventful. If we reflect on Busisiwe's recollection of events, it seems that the note of 'uneventful' might be referring to the surgical procedure itself, rather than to Busisiwe's experience of her postoperative recovery! As we reflect on how Busisiwe was feeling afraid and anxious about having surgery again and was not feeling ready to go through it again, it seems that once again the opportunity to educate and empower Busisiwe in the preoperative period was missed.

Intraoperative pain management of Busisiwe's second surgery

For her second surgery, Busisiwe was given a general anaesthetic and no epidural or regional anaesthesia were used. In addition to the general anaesthetic, she was given fentanyl (2ug/kg), dexamethasone (8mg), and morphine (6mg). At the end of the surgery, regional intercostal nerve block anaesthetic techniques were done using 25 ml 0,5% bupivacaine. Finally, a wound infusion catheter was placed with an appropriate dose of local anaesthetic.

Postoperative pain management of Busisiwe's second surgery

Busisiwe was taken straight to the cardiothoracic ICU this time and not to the PAHCU. On admission to the ward, she was assessed by an anaesthesia registrar (a more senior doctor). The notes report that Busisiwe was comfortable. She was prescribed paracetamol IV (perfalgan), 6 hourly morphine IV boluses, two doses of a NSAID (cox2 inhibitor) and local anaesthesia for the wound infusion. The IV paracetamol was combined with a morphine PCA from the day after her surgery and this combination was maintained until the fourth day. Busisiwe only needed one dose of morphine bolus which she received on the first day after her surgery. This time, Busisiwe received multimodal analgesia as recommended by guidelines.

DON'T MISS THIS

The ideal multimodal analgesia plan for thoracotomy

Multimodal intraoperative analgesic strategies are fundamental for a good surgical outcome from a thoracotomy. The PROSPECT guidelines for thoracotomy pain based on existing evidence suggest regional anaesthetic techniques and multimodal analgesia, including pharmacological and nonpharmacological approaches, should be used for best results (11).

The multimodal approach should focus on the appropriate use of regional or neuraxial (epidural analgesia. This allows for an opioid-sparing technique to prevent hypoventilation or respiratory depression due to increased analgesic needs (short-acting opioids) of the individual. This will also contribute to reduce the duration of opioid use and therefore side effects and potential dependence. In addition, the combination of paracetamol and NSAIDs initiated intraoperatively and administered by-the-clock postoperatively are essential.

Valuable non-pharmacological pain management approaches include educating the person having surgery about the procedure and what to expect, how to work with the team in terms of reporting their pain, how to use their PCA (if one is being used) and on the value of self-management strategies. Self-management approaches include distraction and reassurance, breathing and relaxation and the use of TENS (78). TENS administered at the wound can significantly reduce the need for pharmacological pain management.

In addition to the above pharmacological management of her pain, Busisiwe received regular physiotherapy. Her physiotherapy treatment included education about how to move in bed and how to get out of bed using methods which reduce the chances of pain. Physiotherapy treatment also included a focus on breathing to enhance lung expansion. These breathing techniques are combined with relaxation approaches and diaphragmatic expansion which are effective for reducing pain (97). The physiotherapist also focused on working with Busisiwe in her rehabilitation, making sure she used the PCA prior to mobilising out of bed so that she had the maximum benefit of the medication during her treatments.

Physiotherapy could also have included the use of a TENS machine. TENS at a setting of <10Hz could be used with the electrodes placed at the spinal level of T4 to stimulate an endogenous opioid response. This method would generate analgesia and could be used as an opioid sparing approach. TENS could also be used at a dosage of 100Hz with the electrodes on either side of the surgical wound (78). This dosage would work at the level of the spinal cord by stimulating sensory fibres and reducing the nociception transmitted through the second order neuron up to the brain (97). The combination of pharmacological and non-pharmacological pain management meant that Busisiwe had a much better postoperative experience after her second surgery and mobilised rapidly out of bed, walking significant distances by the second day after her surgery.

Busisiwe has a message about pain!

> *I've learnt, before I would know someone is pain, I would know my children are in pain, when they say they have a headache or a stomach-ache. I would know it's a stomach-ache or a headache. But now, since I have had so much pain, I would not ignore, I would do much more, do better so that whoever has a pain gets help immediately. Because I have learnt from the pain. Now I know what pain is – don't ignore it!*

Lessons learnt

Busisiwe was afraid but she was brave too! She had a really hard time prior to, and after her first surgery but she was brave enough to come back for the second surgery. For both admissions, the opportunity to educate and empower Busisiwe preoperatively was missed. Her pain management could have been optimised preoperatively with a short conversation about what to expect and how she could work with the team to manage her pain. Alternatively educational pamphlets, short videos or educational posters can be used to give people information to raise their self-efficacy going into surgery.

Busisiwe's intraoperative pain management could have been optimised with the use of a standard protocol or guideline for multimodal analgesia for thoracotomies. Making sure that such standard protocols are available for every member of the surgical team and that these are visible in theatre can help to ensure that care is optimal.

Multimodal pain management involving all members of the team, including the person having surgery and their families, can make a significant difference to people's experience and to their final treatment outcomes. Thank goodness Busisiwe was brave enough to come back for her second surgery. What might the outcomes have been if her terrible pain experience from the first surgery meant that she chose not to have the second surgery?

6 Burns

"Please be gentle": Managing burns and paediatric pain in the hospital

Jocelyn Park-Ross
Asma Salloo
Susan Carolus
Samantha Marchant
Nikki Allorto
Romy Parker

An accident means it isn't my fault

My name is Leah, and I am 9 years old. I live in Strand, we were visiting my grandmother in her town with my Mommy, my aunt, and my baby cousin who is 9 months old.

I was standing holding my cousin and I was holding the kettle and he pulled the kettle and it spilled water and on me and my cousin. I screamed hard! I dropped my cousin! And I was not even a little bit OK but I was a little bit scared. It was sore. The ambulance people gave me some medicine to help with the sore, they give me medicine in my mouth and it helped a little bit. The ambulance say where you get burnt – I said I got burnt on my arm and my body and my leg. And then I went for a ride in the ambulance.

First, I go to hospital they give me an injection just here, and they make me got to sleep. Then I come to Red Cross. We came to Red Cross by ambulance with Mommy.

DON'T MISS THIS

Leah's emergency care

Leah's story starts in Section 4 when we hear about her accident and her journey to hospital! To learn more about emergency pain management for burns, please read Leah's story in section 4.

Epidemiology

As many as 1.6 million South Africans suffer a burn injury every year with 10% requiring admission to hospital (97). 80% of those who suffer burn injuries are children under the age of 10 (98). Mortality from burn injuries are high in sub-Saharan Africa with one in five dying from the burn or subsequent complications (98). Investigation of institutional capacity to care for burns in South Africa suggests that it is not a lack of facilities that contributes to poor outcomes, but rather that there are deficits in the patient journey. One of the major deficits is a lack of adequately trained staff such as surgeons trained in burn care. Protocols and guidelines are useful tools to ensure optimal care if education and training are lacking (97).

Poor Leah has suffered a scald – a burn injury from hot water. In children, scalds are the most common burn injury reported (71% of cases) with open flame burns second (24%) (98, 99). At Red Cross War Memorial Children's Hospital, in Cape

Town, a scald injury from pulling on a kettle is one of the most common ways that children (particularly toddlers) are injured. In adults, open fires are the most common cause of burns (68%) with scalds presenting in 25% of cases (98).

Over 3000 people per year require surgical intervention after being admitted to hospital for management of a severe burn injury (100). Admission to a specialist burn centre is indicated for people whose burn is more than 20% of the total body surface area (TBSA) or whose burns are of a special nature (101).To adequately manage these injuries, hospitals need dedicated units with interdisciplinary teams which include surgeons, anaesthetists, nurses and rehabilitation professions like physiotherapists and occupational therapists to adequately manage their injury and its associated pain to optimize recovery. Leah is receiving treatment from all the members of the team.

Leah's mom tells us more

> *I was busy on my phone, and she asked me if she could hold her cousin. I was busy with timesheets on my phone, they went into the kitchen where my oldest daughter was busy. I heard this scream, and I thought they were fighting again. I saw Cayden was burned and his face was red, I took his clothes off and put cold water on him. Why are they still screaming? Then I saw that she also got burnt. I called the ambulance two or three times. We just took her clothes and go with the ambulance to hospital. When it happened, I didn't feel sorry for them I just thought how I must help them. She was very brave – she just stood there shaking, telling my mother she was cold.*
>
> *At hospital they gave her an injection so she can sleep while they clean the wounds. While I was standing next to the bed, I felt a bit dizzy as I saw how badly she got burnt. We waited for the ambulance to take us to Red Cross Hospital.*
>
> *When we got here, I didn't realise we would stay so long. I didn't think the operation would be that big on her, it was really hard when my sister went home. It's hard. It's hard to see her in pain. There isn't anything I can do to help her, only to be here so she can see that Mommy is here.*

Pain assessment

We will now describe Leah's assessment as if we are seeing her in the hospital ward.

Assessing pain in children is an essential skill! For many children, their pain is not well assessed and undertreated as a result (102). There are many challenges in assessing children, including their anxiety and their neurodevelopment age. As we read in Section 1, there are different pain rating scales and tools that we can use to assess the severity of pain. Assessment is vital as a benchmark, so that we can reassess to ensure our pain management plan is working.

When assessing pain in children, consider the caregiver as an important partner in gathering information. Leah, at the age of 9 is old enough to answer our questions (Table 6.1). For many children who are too small to communicate, especially those under the age of 5, we ask the caregiver if their child is in pain – they will tell us if their child is restless, not sleeping or eating, and whether they think they are in pain.

DON'T MISS THIS

Assessing pain in children

At the start of Leah's story in Section 4, we have a Deep Dive on assessing pain in children which has important information about gathering information to assess pain.

Table 5.6: Our OPQRSTUVW for Leah

Gather information on the...	What questions to ask	Leah's pain	What did this information tell us?
Onset	• When and how did this start? • How long does the pain last? • How often do you get the pain?	Leah's initial injury was a burn with hot water, but since then she has had two surgeries, multiple dressing changes and moves around the ward for her daily ablutions and some physiotherapy – all of these things are sore!	We can consider what Leah's baseline pain management strategy is (when she is comfortable and lying in bed) and plan to pair increased procedural analgesia with activities which cause more pain.
Provoking and palliating activities	• What causes the pain? • What makes it better? • What makes it worse?	Leah tells us the dressing changes are sore, but she is comfortable when she is in her bed. She goes on to tell us below that she didn't experience too much pain when she had her skin grafts, and that her pain is well managed.	Anticipating the need for analgesia and non-pharmacological pain management strategies is an important part of this assessment – and should be an ongoing part of the assessment and reassessment of our analgesia plan, including our baseline plan and procedural pain management plan.
Quality of the pain	• Can you describe your pain?	Leah has told us over and over that it is very sore when she is moved too much or when the bandages are taken off!	Children may struggle to describe their pain quality, and so we use our mechanisms-based approach to understand the pain.
Region or radiation	• Where is the pain? • Does the pain spread? • Where does it spread to?	The pain is localised to the area of the burn.	It is understandable based on the nature of a burn injury that the pain is localised to the area of the burn, but there may also be areas of the burn with limited sensation.
Severity	• How severe is your pain? • How severe is it right now/at its best/at its worst and on average? • How severe is your pain when you try to be active?	Leah tells us she is comfortable on her bed and that the pain is minimal, but her pain is severe when she moves too much or when the bandages are removed, or the wound washed.	We can expect that even minor wounds are painful. As we anticipate what makes the pain worse, we can plan procedural and baseline analgesia.

Gather information on the...	What questions to ask	Leah's pain	What did this information tell us?
Treatment	• What treatment have you tried for your pain? • How well has it worked? • Have you had any side-effects from these treatments?	Leah is comfortable in her bed and is happy with the medication she is getting to keep her comfortable. She is scared of the dressing changes and is clear that she needs analgesia and clear communication around having her dressings changed, and she asks us to be gentle with these dressing changes.	Leah would have had varying multimodal analgesia at different stages of her care, including in the postoperative period. More options are discussed below, but a combination of clonidine, gabapentin and paracetamol are recommended.
Understanding beliefs and impact	• What do you think is causing your pain? • What do you think is wrong? • What can you not do because of your pain?	Leah is clear that dressing changes are very sore, and she is scared of them. She is just starting some physiotherapy and that is also sore.	Anticipating painful activities and experiencing ongoing pain means that Leah struggles to do her physiotherapy and experiences anxiety around being moved or having her dressings changes, which can worsen her pain.
Values	• What do you like doing and want to do (playing, being with friends or family, reading or going to school) that pain is stopping you from doing?	Leah would like to get better and go home to her family. She finds dressing changes scary and physiotherapy like moving and walking is hard because it is sore.	Communicating about painful or anxiety provoking situations that Leah has mentioned helps her healthcare team to explain to Leah what to expect, and to be active in anticipating her need for analgesia. It would be good to involve Leah's mom and other caregivers that the healthcare team is aware of Leah's concerns and communicate with them about what is being done to manage her pain as best as possible.
What else?	• What else is going on in your life? • How are you generally?	Leah has been in hospital for a while recovering from her burn, and her Mom sometimes has to return home to look after the other children. Leah is missing home and her family.	The healthcare workers looking after Leah need to be mindful to maintain good communication and understanding with Leah and her Mom to make sure they understand Leah's needs.

Leah's road to recovery

> *I've had operations. When I go to sleep, they put that mask when I can sleep. I didn't get sore even then. I didn't even feel nothing, and I didn't even get sore – I only sleep. In my operation they do my arm and my hip – they put new skin on for me. After the operation when they took off the mask, I cannot even open my eyes. Then they put me in bed, now I can see my Mum and my Dad.*

> *I've had an operation on my arm and one on my leg and my hip. No more operations. Every day they give me pain medicine. They give me yellow medicine and black medicine and they give me the pills. It helps to keep me comfortable.*

Mechanisms of pain

Leah is suffering from ongoing acute nociceptive pain with sensitisation at both the peripheral and spinal cord levels. In addition, the ongoing trauma from her repeated surgeries and dressing changes, combined with the psychosocial factors associated with being in hospital will be upregulating the brain and synergistic systems. While the nociceptive system would have been activated by the initial burn injury (as discussed in Section 4), the ongoing tissue healing processes now contribute further to sensitisation. Leah will have allodynia and hyperalgesia indicating that the both the peripheral nervous system and the spinal cord neurons are sensitised.

Peripheral nervous system

In the peripheral nervous system, the Aδ- and C-fibres (nociceptors) will be sensitised. In an injury of this scale, the Aβ-fibres (which when they are free nerve endings also behave as nociceptors) would also be sensitised and contributing to nociception. The sensitisation of all these peripheral fibres would have been initiated by the axonal- and dorsal-root reflexes at the time of the injury, resulting in neurogenic inflammation from the release of substance P and CGRP by the neurons when the initial thermal stimulus occurred at the time of the burn (103).

The cellular damage of a burn contributes to significant peripheral sensitisation which drives nociception and other symptoms like burn itch.

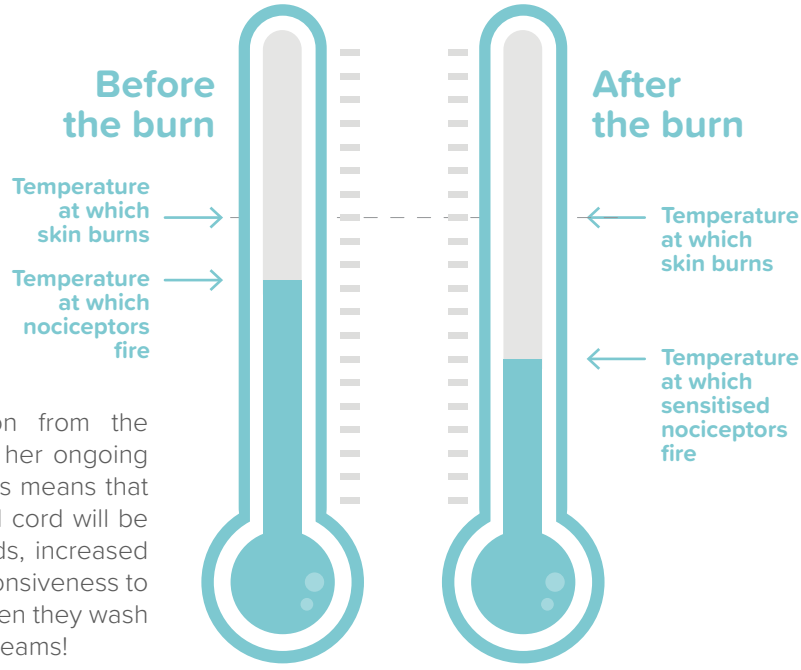
The burn injury will also have resulted in cellular damage to the skin with a consequent inflammatory response. A burn causes denaturing of proteins and cell plasma leaks into the tissues as the cell membranes are damaged. The leaking cell plasma contains damage-associated molecular pattern molecules (DAMPs) which bind to inflammatory receptors and stimulate the immune system to respond to the injury (104). The inflammatory response would include the release of inflammatory mediators such as prostaglandins, bradykinin, and histamine which, combined with the substance P and CGRP further sensitise the nociceptors and as well as driving nociception, contribute to other symptoms such as burn itch.

Elevated levels of substance P and CGRP during tissue healing from burn injuries have been correlated with ongoing pain during the healing process (104). You should recall from Section 1 that sensitisation means that the nociceptors would now have a reduced firing threshold, an increased responsiveness to stimulation and silent nociceptors in the area are activated in a sensitised state. Leah will be experiencing primary hyperalgesia – excessive pain from normally painful stimuli in the area of tissue damage. Each time she has a dressing change, the normally painful stimulus will be amplified!

Spinal cord

Leah is also suffering from allodynia and secondary hyperalgesia indicating that the spinal cord is sensitised. Spinal cord sensitisation occurs rapidly in response to burn injures via activation of the NMDA glutamate receptor in the second order neuron in the spinal cord (104). The sensitisation in the spinal cord is also driven by circulating levels of inflammatory mediators which are present due to the tissue damage. Shortly after suffering her burn, Leah would have had elevated levels of CGRP and substance P plus circulating DAMPs, all of which would have sensitised the nociceptive system in the central nervous system (104). Not only will the neurons

be sensitised, but microglia will be activated releasing proinflammatory cytokines. The synapse in the spinal cord between the primary and secondary neurons will be primed to fire easily with high levels of glutamate, increased expression of ion channels, and increased expression of proinflammatory cytokines (e.g. TNFα; IL1β).



The ongoing barrage of nociception from the periphery as a result of the injury and her ongoing treatment and regular dressing changes means that the second order neurons in the spinal cord will be sensitised with lowered firing thresholds, increased receptor field sizes and increased responsiveness to stimulation (105). It really will be sore when they wash Leah and it is not a surprise that she screams!

Brain

Leah certainly is in a threatening situation, and it is appropriate that her brain is generating pain. Leah's pain is motivating her to withdraw and keep still to facilitate healing, and motivating her to communicate with those around her that she needs help and support. Multiple areas of Leah's brain will be active in generating her pain. Some areas that may be particularly active are her hippocampus and amygdala. Each time she has a dressing change, the cold shower, the pain, will all form memories and these may link with activity in the amygdala generating fear – remember Leah says: "*it feels scary knowing that I need to be washed*". All of her experiences will be contributing to her pain.

It is possible that the fear that Leah is experiencing in anticipation of the dressing changes is reducing activity of her descending inhibitory pathways resulting in increased descending facilitation. Leah has received good support from her Mom who has reassured her that the accident was not her fault. Mom might be creating a sense of safety for Leah which would counter the fear and activate her descending inhibitory mechanisms. Non-pharmacological treatments used for managing burn pain such as virtual reality distraction work by activation this system. Do you remember from Section 1 that the endogenous opioid generated in this system is 30 times stronger than oral morphine?

Synergistic systems

It is clear that Leah is having a hard time in hospital. She has some worries that the accident was her fault. She is afraid of the dressing changes. She misses home. All of these emotions will activate the autonomic and endocrine systems. The tissue damage from the burn will also activate the immune, endocrine and autonomic systems. This means that all of Leah's synergistic systems are primed to increase her pain. It is good to see that she has no pain when she is still, and she seems to be able to get good sleep. However, all these systems will need to be continually monitored to optimise her healing and recovery and reduce the risk of Leah developing chronic nociplastic pain from her injury.

Leah says please be gentle

> *Now I'm back in my bed. I'm comfortable in my bed. Nothing is sore when I am lying. I'm not walking around yet. Sometimes they have to change my dressing. I go to the dressing room, but I'm scared of the dressing room. They wash me with cold water, but I don't like cold water! Its sore when they wash me, and I scream! Then they put me back in my bed. It feels scary knowing that I need to be washed.*
>
> *It gets very sore when I get burnt. Please be gentle. When they are going to wash me, they get the doctors first and they take the bandages.*

Pain management

All children (and adults!) with burns will experience pain, regardless of the cause, size, or burn depth. Burn pain is dynamic in nature and causes more rapid metabolism of analgesic drugs due to a hypermetabolic state (106). Any movement or touch to the burnt area may provoke pain i.e. allodynia. Children with burn injuries will be exposed to repeated procedures such as intravenous lines, drawing of blood, dressing changes and physiotherapy rehabilitation – all of which will be painful. Undertreated pain can result in people struggling to adhere to these treatments and, consequently, prolong the healing process. Burn injuries in children can be quite extensive and devastating and often all the focus is on managing the burn injury with dressings, fluid and physiological resuscitation. The extent of pain and intensity of pain experienced by the child may sometimes be overlooked. Coupled with pain is anxiety; pain causes anxiety, and anxiety increases pain. Anxiety experienced by caregivers can manifest in various ways and should be pre-empted using verbal and non-verbal communication to help quell the caregivers' anxieties and fears. Together with the initial burn injury, all of these aspects add to the child's experience of pain.

Healthcare workers should be cognisant of these important considerations and engage with caregivers to explain the processes and procedures involved in the care of their child. Explain to caregivers that the child is likely to be admitted to hospital for a prolonged period of time with multiple procedures to manage the different aspects of burn injury such as wound management, sepsis, dressing changes, debridement, skin grafting and rehabilitation. This explanation would have helped Leah's mother to have more of an idea as to what to expect and to help manage Leah's expectations. At every step of the recovery process, health care workers need to build rapport and explain to caregivers what is being done for the child and what is required of them in the circumstances. Caregivers may also be overwhelmed by the entire situation surrounding the burn and may still be processing what happened or led to the accident and therefore clear messages and requests are important.

DON'T MISS THIS

Optimising the caregiver's contributions

While a caregiver may ease the anxiety and pain of a child, an anxious caregiver or parent may increase the child's pain!

Some tips for creating a good rapport with a child's caregiver:

- Communicate clearly about what to expect – including what procedures might be done and why, the recovery journey and the roles of different members of the healthcare team
- Partner with the caregiver to help the child cope with and understand their pain, using explanations appropriate for their neurodevelopmental stage, including providing comfort and distraction.
- Work with the caregiver to gather information to help guide your decision making. Caregivers can provide important insights into the child's comfort and behaviour, and form a vital part of the assessment and re-assessment of pain – even if the child cannot communicate themselves.
- Ask for and listen to any questions and worries the caregiver may have – you need an empowered and reassured caregiver to support a child in pain. (107-109)

Non-pharmacological pain management

There are many actions that we as Leah's healthcare team can take to manage her pain – and the non-pharmacological management is just as important as the pharmacological, especially for children. We must actively work to keep her comfortable, let her rest and be comforted by her caregiver, and decrease her anxiety whenever we can. When conducting this interview, we created a space where we could talk to Leah that was quiet, and away from other children who may have been in distress. We asked her Mom to remain with her and comfort Leah, and to talk to Leah with us in a calm voice. As her healthcare team, we want to be sure that we have created a relationship with Leah which builds trust – we can decrease her anxiety (and her mother's) by telling her what to expect and giving her a chance to answer questions. This relationship helps us to care for her better and helps Leah to feel empowered to manage her own pain by speaking up for herself when her pain is worse (110).

Pharmacological pain management

Pharmacological choices in pain management always balance the mechanisms causing the pain with the severity of the pain, and in burn pain we aim to manage the background pain, increased pain during procedures or other painful events, and the post-burn itch. Two core concepts in pain management in children which have been used with Leah, are a focus on oral administration of analgesia and a multimodal analgesia regimen (102). Multimodal analgesia improves pain control and provides best functional outcome in children (102). A widely encouraged principle for analgesia administration in children is to administer medication orally in either tablet, suspension or syrup form (114). Other common routes for administration include sublingual, rectal, subcutaneous and intravenous. Oral medications commonly used in paediatric care include paracetamol, NSAID's such as ibuprofen, clonidine and gabapentin. Burns are incredibly painful and effective

analgesia needs to be provided early and continually, with regular reassessment to guide the planned analgesia. A multimodal approach is utilized as guided by regular assessment with feedback from the child and caregiver, as well as discerning between, and managing, baseline pain management and procedural pain management.

DON'T MISS THIS

Not all pain management includes drugs!

There are many important parts of pain management to consider before planning analgesia, and for children the anxiety of the experience is a large contributor to their experience. (107-112)

Category	Strategies
Environmental	Create a child-friendly and calm environment, control the visuals and the sounds a child experiences. Try to reduce noise (especially of other distressed children), dim bright lights, reduce monitor alarms.
Emotional	Ensure the caregiver is present and actively involved in care where possible – include the caregiver in the treatment plan and encourage them to talk to the child in a calm voice and provide reassurance. The healthcare team can also use calm voices, positive affirmations and active reassurance to both the child and the caregiver.
Cognitive	Engage with the child and caregiver and explain what procedures and actions are planned – such as blood tests or medication administration, and why these are being conducted. Distraction is a powerful tool! Allow the child to play music or play games, encourage toys and distraction. Virtual reality games and immersive play are very effective in reducing procedural pain (113) Talk to the caregiver and child (where appropriate) about pain mechanisms. Encourage mindfulness techniques such as deep breathing.
Context	Group procedures and anticipated painful experiences to reduce handling of the child and encourage rest.
Physical	Consider the physical experiences which can decrease pain – these strategies differ for different age groups and range from breast-feeding, to using a dummy or pacifier, Kangaroo Mother Care or being held by a caregiver, massage/touch and warmth.

DON'T MISS THIS

Baseline pain versus procedural pain

While perioperative pain is viewed as decreasing over time, in the context of burns and other conditions needing intensive rehabilitation, or for procedures causing more pain than baseline, anticipate increased needs for pharmacological and non-pharmacological pain management. This may include communication, distraction and increases in medication offered. Baseline pain should be treated with background analgesia, while medication top-ups and additional non-pharmacological treatments are administered prior to procedures and rehabilitation such as physiotherapy.

Background pharmacological analgesia for all burn sufferers must include paracetamol, with the addition of ibuprofen and/or morphine syrup if the pain is not controlled, and clonidine and/or gabapentin if the pain has a neuropathic mechanism. After admission into hospital after her hospital transfer, Leah's multimodal analgesia plan included oral paracetamol, clonidine and gabapentin. The combination kept her comfortable in bed but can make her feel a bit sleepy and sedated at times. Her Mom tells us that she is calm and comfortable!

Paracetamol is commonly used in paediatric care. It has a favourable safety profile. The major concern is liver toxicity, but this is mainly as a consequence of overdose. Paracetamol can be administered once enteral feeding has been established or intravenously in the acute phase. Recent evidence comparing the efficacy and onset of oral compared to intravenous administration is clear – they are equally as effective (115)! Oral administration is cheaper and less traumatic for the child than establishing intravenous access. To optimize its effectiveness, paracetamol should be administered early and by the clock.

Clonidine is an alpha 2 adrenergic antagonist which targets receptors in the brain and spinal cord. Clonidine has anxiolytic effects and is opioid-sparing, reducing the need for morphine and other opioids (106, 116). Clonidine has also been shown to reduce sympathetic overactivity in people who have suffered burns (116).

Gabapentin is used in the management of neuropathic pain following burn injury. Gabapentin is the gabapentinoid more commonly used in paediatrics compared with pregabalin as dosing is easier. It binds to presynaptic calcium channels in the spinal cord nociceptive pathway and indirectly inhibits NMDA receptor overactivation. As it targets spinal cord mechanisms, it is effective in the reduction of burn-induced secondary hyperalgesia and allodynia. Gabapentin has also been found to be effective in the management of itch in children which is very common after burn injury as the wounds heal. It can be used when other simple anti-itch medications such as chlorpheniramine or cetirizine and other antihistamines are not providing relief.

Multimodal analgesia for a burn must include paracetamol, an NSAID, opioid, clonidine with a gabapentinoid if there are neuropathic mechanisms.

NSAIDS like ibuprofen can be used as an adjunct to opioid analgesics in the management of pain in children who have suffered burns. These medications provide analgesic and anti-inflammatory effects by inhibiting the production of prostaglandins, which are involved in the inflammatory response. NSAIDs would be reserved as an adjunct medication for use later in the burn injury once enteral feeding is well established and in the absence of sepsis and low platelet counts. It is important to consider the potential side effects of NSAIDs, such as gastrointestinal bleeding or renal impairment, especially in people with pre-existing conditions or with prolonged use (106). Weak opioids such as tramadol and tilidine drops (Valeron) are also used – although there are challenges in accessing tilidine drops as it was discontinued by the manufacturer.

When Leah has come out of surgery after her skin grafts or when she has needed particularly painful burn dressing changes, her healthcare team have included a stronger opioid (postoperative pain) or ketamine (procedural pain for dressing changes) with the baseline medication. Many children who have sustained burns will have intravenous access established for fluid resuscitation in the acute and perioperative setting, which means that the child can be given an infusion for pain management or procedural sedation when needed. For children requiring intravenous administration of opioids and ketamine, regular monitoring of vital signs (including heart rate and pulse oximetry monitoring) and regular reassessment are indicated. Stronger opioids such as morphine and fentanyl can be administered orally (morphine syrup), or intravenously. There is sometimes a hesitancy among healthcare workers to use opioids in children because of the risk of side-effects, for example respiratory depression, but these side-effects are usually rare, and with correct dose and adequate clinical monitoring, opioids can be safely prescribed and administered to children of all ages. Be careful of often missed side effects of opioids like constipation and urinary retention, especially with prolonged use.

Ketamine is an essential component of care for people who have suffered burns to manage severe baseline pain and for procedural pain management in inpatient and outpatient settings. Ketamine is safe and effective with minimal side effects, and can be administered orally, intravenously or intramuscularly (117, 118). Ketamine acts on both the central and peripheral nervous system and can be given as a single dose or infusion. At lower doses, ketamine provides good analgesia, and at higher doses produces dissociative sedation which is useful for procedures such as scrubbing or wound dressings. Co-administration of a small dose of midazolam with ketamine provides a synergistic effect (104, 106, 118). In low resource settings with limited staff available for monitoring or when people do not have an intravenous line, oral or intramuscular ketamine is a safe and effective analgesic for baseline pain management and especially for procedural pain management.

Procedural pain management during dressing changes requires adequate analgesia to enable proper cleaning of the wound. In people with tachyphylaxis, it is essential to give increasing doses until appropriate analgesia to allow for a wound cleaning is achieved. We must always ensure, to the best of our ability, that people are as comfortable as we can make them during dressing changes and wound cleaning – never compromise and continue with dressing changes and wound cleaning in the presence of active pain! Wait, give more analgesia and re-assess. At higher doses of ketamine, people experience dissociative sedation which means they won't experience or remember the painful experience, and consider a small dose of midazolam to act synergistically to augment the ketamine.

For more severe baseline pain or complex burns, a ketamine and morphine infusion is a useful baseline pain management strategy. The use of ketamine in combination with morphine in an infusion is an opioid sparing multimodal strategy which can improve pain relief and minimize opioid side effects. All children on ketamine infusions must be monitored with continuous pulse oximetry.

Morphine is the most commonly available opioid. Its acts on the opioid receptors which are present throughout the central and peripheral nervous system and sometimes also present in non-neuronal tissue. Morphine can be given as a single intravenous injection or as a continuous infusion. Morphine infusions should ideally be used in a high care area with monitoring available.

DON'T MISS THIS

Calculating infusions and doses for pain management

Calculating drug doses and infusions in children is difficult! Prepare yourself ahead of time by finding a resource such as your hospital or other guidelines, or the EMGuidance app.

Note: These doses may change as evidence changes! Remember to always check a reference such as the South African Medicines Formulary, your local/hospital guidelines or an evidence based clinical guideline before giving a medication.

DON'T MISS THIS

Message from a Pain Nursing Sister

The nurse is one of the most important advocates for pain management and is a vital member of the team! Nursing team members must be actively engaged in the assessment and ongoing planning of pain management for the person with pain. Nurses are at the bedside and with the opportunity to get to know the person in their care well when they engage in daily activities with them. With this knowledge, nurses are able to guide pain management strategies. Nurses care for people holistically and are a vital part of the non-pharmacological management of pain – paying attention to the person's environment, emotions, cognitive, contextual and physical experience of pain.

It is important with all pain management strategies, including epidurals, wound infusions, PCAs and other infusions, that the nurse is empowered with the knowledge, skills and insight to manage, recognize and report how well the pain management strategies are working. Nurses are also able to report adverse effects timeously and able to act to minimize complications.

Assessment planning and implementation and evaluation of pain management strategies are crucial in the management of pain in children. To achieve this, nurses must perform regular checks to ensure safety and be aware of the adverse effects – whether this is how to check the site and catheter of the infusion, the drug infusion dosing and how to regularly obtain vital signs. It is important in all healthcare systems that all members of the healthcare team are aware of where to report changes in the needs of the person in their care or where to ask for help in order to minimise and prevent complications.

DEEP DIVE

More options for pain control in the perioperative setting for a child

Epidurals, wound infusions and Patient Controlled Analgesia (PCA) are options for perioperative pain management in children. If a child is receiving any of these options, the healthcare workers caring for that child must be prepared and trained in the use and monitoring of the differing modalities. Consider if the child should be nursed in a high care space with higher nursing ratios than a ward space, and how well prepared the team is to identify and respond to any problems which may arise. In all cases, the pain management plan, including the use of any of these modalities, must be well documented and clearly communicated when nursing teams are handing over the care of the child to the members of the next shift, or to another ward.

Epidurals postoperatively are used as part of multimodal analgesia to optimize pain control and comfort. An epidural is an infusion of a local anaesthetic (usually bupivacaine 0.1%) via a catheter inserted into the epidural space (normally L4 and L5 lumbar spine) managed by a pump or syringe driver. They are most commonly used to manage the pain of surgery. Epidurals are most commonly inserted by an anaesthetist. For maximum benefit they should be kept in place for a minimum of 24 hours and are often used for 72 hours postoperatively. Nursing teams must regularly check that the epidural catheter is intact and not leaking, that the catheter depth of insertion is correct and that there are no signs of infection. Correct dosing of the infusion according to weight is vital for safe administration.

Another tool in multimodal anaesthesia is the wound infusion. Wound infusions use a multi-holed catheter which is placed inside the wound to manage postoperative pain by administering local anaesthetic (specifically bupivicane 0.2% for children older than 4 months old, and 0.1% for children younger than 4 months). Wound infusions are commonly placed by the surgeon. Wound infusions are considered safe and can be used in a surgical ward setting.

Continued...

Patient Controlled Analgesia (PCA) is delivered by a pre-loaded pump with a button that the person who has had surgery can use to control the administration of their analgesia. PCA pumps are programmed to deliver a background continuous infusion, with a button allowing the person with pain to give top up doses to manage their pain themselves. Safety mechanisms on the pumps include a five-minute lockout time – meaning the button can only be pressed to deliver a dose every five minutes. The pump also continuously calculates the total dosage on an ongoing basis to prevent overdose. The pump computer screen gives the healthcare worker information about the amount of analgesia delivered, number of times the button has been pressed and how many times the top-up analgesia was given. To be able to use a PCA pump, children must be at a neurodevelopment stage where they demonstrated an understanding of the PCA and are able to operate the remote-control button, usually aged 5 years or older. They must also be awake and alert. It is important to give information to both the child and the caregiver in the form of an information leaflet and discuss the PCA with them. When possible, it is useful to show the PCA to the child and their caregiver and demonstrate its use before the PCA is initiated. Ensure that both the child and the caregiver are able to ask questions and feel comfortable with the device. A PCA is controlled by the person who has had surgery – therefore the healthcare team and caregivers must not press the button! However, they can remind the child if he or she verbalizes they are experiencing pain.

Table 5.7: Summary table of pharmacological management of paediatric burns (106, 116, 119)

Pain severity	Analgesia options	Comments
Baseline for all patients	• Paracetamol and consider NSAID (ibuprofen)	For NSAID the concern is masking thrombocytopenia from sepsis and risk of kidney injury - ensure normal renal function, platelets normal
If breakthrough pain	• Paracetamol with or without NSAIDs AND • Weak opioid: Morphine Syrup PO OR Tramadol SL	
Severe Pain **Large surface area burns** **ICU or Highcare** **Post-operative or increased pain**	• Paracetamol with or without NSAIDs AND • Strong opioid: Infusion or top up dosing of Morphine IV OR Fentanyl IV OR Ketamine IV • Dexmedetomidine	Titrate infusions for effect, and ensure patient vital signs monitoring and vigilance of adverse effects. Consider PCA for ongoing moderate to severe pain expected to last > 24 hours
Neuropathic pain	• Gabapentin OR pregabalin • Clonidine	Can be used with any pain severity, and is strongly suggested with moderate/severe pain.
Procedural pain management options	• Weak opioid: Tilidine SL OR Morphine Syrup PO OR Tramadol SL • Strong opioid: Infusion or top up dosing of Morphine IV OR Fentanyl IV OR Ketamine IV • Dexmedetomidine	Guided by severity of pain and nature of procedure, additional to baseline analgesia
Itch	• Gabapentin OR pregabalin (Tegretol or allergex if not available)	
Interventional modalities	• Regional anaesthesia	Indwelling catheters should be considered for pain expected to be severe > 48 hours
Anxiety, delirium and sleep	• Valium, haloperidol, amitriptyline	Valium for PTSD, opioid withdrawal or anxiety Haloperidol for delirium Amitriptyline for pain at night or difficult sleeping

DON'T MISS THIS

Oral sucrose analgesia

In neonates and infants, oral 25% sucrose can be given orally, or applied onto a pacifier or dummy, and can provide an analgesic effect for 5-8 minutes. Administer the glucose 2 minutes before a painful procedure for best effect (120).

DEEP DIVE

Anticipating dressing changes

Children who have experienced a burn are subjected to multiple dressing changes over the course of their healing, and these are very painful! Dressing changes should ideally happen in the operating room but can be done in a procedure room within a ward. Scrubs, debridement and skin grafts would be ideally done in theatre with an anaesthetist under general anaesthesia.

The healthcare team can decrease the pain and anxiety of these experiences by:

- Creating a child friendly environment with multiple options to use distraction techniques like TV's, looking at pictures and playing with appropriate toys, and by engaging with any requests the child or their carer might make to make themselves more comfortable.
- Providing multimodal procedural anaesthesia anticipating the increased pain and communicating with the child and their caregiver that they are receiving more analgesia to help with the pain.
- Communicating clearly with the child and their caregiver about the procedure to reduce anxiety of the unknown and empower the child and caregiver to feel like partners with the healthcare team.

"I'm really happy with how the sisters and the doctors are. They come check every time if she's OK, if she has pain. I don't have any complaints about the work here. Even when I go home and sort the other two out, I leave her with the sisters, and I know they check on her."

- Leah's Mom

Lessons learnt

Our core messages for caring with children with pain:

1: Partner and communicate

Communication with a child's caregiver and with the child about what to expect and how you are partnering with them to manage their pain will help the child and the healthcare team to manage the child's pain. The child's caregiver is often your most powerful ally in understanding a child's pain, comforting the child to decrease their anxiety and directing your reassessment of whether your treatment plan is working.

2: Anticipate!

Anticipate which procedures or moments may cause anxiety or pain, and ensure you communicate and have a plan to manage these moments. Your plan may include analgesia, distraction and partnering with the child's caregiver to reassure the child and decrease anxiety. If possible, try and reduce handling of the child and allow them to rest by clustering procedures or events that may cause pain.

3: Assess and reassess

Assessing pain in children may include children too young to talk, but this doesn't mean they aren't communicating! You can use different tools such as the FLACC, NIPPS or faces of pain scales for children who aren't able to talk, or a numeric rating scale for children who can talk and describe their pain. Their caregiver will also have valuable information to help guide your assessment.

4: Have a plan for calculating dosing

Weight-based dosing may be difficult to calculate, especially in moments of stress. It may be useful to work out these doses ahead of time if possible, or to use an established guideline which guides your dosing.

5: Don't forget the non-pharmacological pain management

You can reduce pain by controlling the experiences of the child and the caregivers of their environment, as well as their cognitive and emotional stress and physical factors.

6: Prioritise oral analgesia where possible!

Remember that there are many administration routes and formularies for analgesia, such as nasal administration, syrups and suppositories.

7 Conclusion

Romy Parker
Tracey Hargreaves
Bongeka Ndoda

To effectively manage pain associated with surgery we need a jazz band – an interdisciplinary team which includes the person who is going to have or has had surgery. The person having surgery and their family or carers need to be actively empowered to be members of the band. The members of the band who make sure it all runs smoothly are the nurses. Nurses frequently take the lead, they may hand leadership over to an anaesthetist, but then the leadership responsibility rapidly comes back to nurses. Nurses may hand over to physiotherapists for a short while, but then again, the leadership will be handed back to nurses. Nurses play a key role all the way through this perioperative journey until final handover to the person who has had surgery at discharge.

Remember that discharge from hospital is not the end of perioperative pain management, people must be empowered to manage their pain at home. It is critical that analgesia has been titrated down to prepare for discharge. Multimodal pain management guidelines all recommend that strong opioids should **NOT** be included in the discharge plan. If someone is sent home with strong opioids, ensure there is clear education about how these are to be used. There is a risk of harm from diversion. There is a risk of harm from accidental overdose. There is a risk of harm from opioid dependence. Make sure that the person who has had surgery and who is now taking over leadership of their pain management understands what medication they have, how to use it, and when and how to contact their team for help.

DON'T MISS THIS

Message from nurses

Never underestimate the value of assessing the fears and concerns of the person having surgery. Allow them to verbalise their fears and worries and ask questions. Encourage them to ask questions regarding the planned procedure and about potential complications.

Make sure every person being admitted is welcomed to the ward by name. Introduce them and their family or significant others to the other people on the ward, this is their community!

If they may be transferred to postoperative recovery high care or intensive care after surgery ensure that they are aware of this possibility.

Explain to the person having surgery and their family what analgesia will be used and what different modes of treatment are available. If PCAs, wound infusion catheters and epidurals are an option make sure they are aware of these and of how to use them to best effect. Make sure they understand how the analgesia will work and what the potential side effects are so that they can be identified early.

Monitor for, record and report adverse reactions.

Ensure any allergies to opioids or other analgesia are discussed and documented.

DON'T MISS THIS

People don't want to bother their healthcare team

People who are in hospital are aware that the people working there are often under pressure. In South Africa people are often stoic, they don't want to bother us. It is important that people who have had surgery know that while some pain or mild pain is OK, we don't want them to be so brave that they are putting up with moderate to severe pain. It is not a bother to tell us about this pain, pain slows down healing!

DON'T MISS THIS

Free resources

There are many guidelines available which are useful for clinical practice. When consulting a guideline make sure you have the most up to date version. The South African Society of Anaesthesiologists Acute Pain Guidelines are a useful example.

SASA-Acute-Pain-Guidelines-2022.pdf (sasaweb.com)

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